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**RESEARCH ARTICLE**

# Symptoms of Carpal Tunnel Syndrome in a dental work force of a developing country

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## *Abstract*

**Background:** Carpal tunnel syndrome (CTS) arises from the compression of the median nerve when it passes through the carpal tunnel in the wrist. Higher prevalence of CTS has been found in certain vocational groups with repetitive hand movements. Hence a study was designed to investigate the prevalence of CTS among dentists and analyze interrelations between CTS and its effect on work related risk factors in Mangalore city. India.

**Methodology:** A cross-sectional study which evaluated prevalence of CTS and the factors that determining CTS among dentists was undertaken. A questionnaire comprising the Symptom Severity Scale (SSS) and the Functional Status Scale (FSS) was used. The overall result is the calculated as mean of all scores.

**Results:** Of the 228 dental professionals 210 responded, with a response rate of 92.1%percent. The population prevalence of pain, numbness, and/or tingling in the median nerve distribution was 20% , a significant association was observed with the years of practice and the symptoms of CTS ($p < 0.001$) and with respect to different strata's for hours of practice. The odds ratio for symptoms of CTS and the associated factors were determined but none of the above factors demonstrated association.

**Conclusion**: The study concludes that the prevalence of CTS in dental professionals is high, ie 20 percent, of which 14.2 percent complained of pain. This had a direct relation to the years of practice of the dental professional, when the diagnosis is made using symptom severity scale.



## Introduction

Carpal tunnel syndrome (CTS) arises from the compression of the median nerve when it passes through the carpal tunnel in the wrist. It is characterized by sensory and, less commonly, motor symptoms and signs in the peripheral distribution of the median nerve. (Palmer KT et al., 2007). It is the most common compressive neuropathy of the upper limb and an increasingly recognized cause of work disability. CTS belongs to a ménage of disorders called Cumulative Trauma Disorders (CTDs) which are caused by repetitive, sustained, or forceful motions occurring over time, compromising the integrity or functioning of the soft tissues producing inflammation of the tendons or compression of the peripheral nerves. (Silverstein BA et al., 1986) The presence of some factors in a occupational cohort that may lead to the developments of CTDs have been labeled as 'traumatogens'. (Atcheson SG et al., 1998)

CTS constitute a major part of the occupational upper-extremity disorders and is associated with considerable health care and indemnity costs. Higher prevalence rates for CTS have been found in certain vocational groupswith repetitive hand movements, especially flexion of wrists and extension of arms. These factors certainly represent the dentists' day to day activities. The dentists and dental hygienists have been reported to have a high prevalence of upper extremity musculoskeletal disorders, including CTS. Lalumandier JA et al., 2007.)

In dental professionals, forceful use of the hand during scaling and extractions, use of vibrating ultrasonic equipment and frequent working with the wrist in flexion or in extension may be the cause of the CTS. The

diagnosis of CTS is based on the characteristic complaints, confirmed preferably by abnormal electrophysiological tests. ( De KromMc et al., 2009.)

Carpal tunnel release is the most commonly performed operation on the hand, accounting for approximately 200,000 procedures each year in the United States and incurring direct medical costs in excess of one billion dollars annually. More rigorous study of treatment for CTS will be enhanced by better measures of outcome. (Levine DW et al., 1993)

The dynamics of the changes happening in the course of occupational exposure to vibration is usually slow and no acute pains accompany them. There appear, however, deformations of articular spaces, changes in the periosteum and in the osseous texture.

In musculoskeletal epidemiology, the exposure paradigm differs from the usual concept in occupational epidemiology whereby, exposure refers to an agent or factor in the environment external to the worker. (Burdorf A et al., 1999) Hand and wrist disorders are receiving the most attention, although their symptoms are reported less often by dental workers than symptoms of neck and/or back disorders. It may be that the motivation for interest in this area has been spurred on by the recently observed significant increase in workers' compensation claims for disabilities in this area or the successes achieved in prevention and abatement of hand and wrist disorders in other industries. (Guay AH, 1998) The most important problem associated with this occupational exposure is the complexity of exposure assessment at the workplace in relation to the musculoskeletal disorders of interest.

The first aim of this study was to investigate the prevalence of CTS among dentists in Mangalore city using a symptom questionnaire. The second aim was to analyse interrelations between CTS and its effect on work related risk factors and musculoskeletal complaints.

## MATERIALS AND METHODS

A cross-sectional study which evaluated prevalence of CTS and the factors that determine CTS among dentists in the city of Mangalore was undertaken. Subjects who have successfully completed their degree in Bachelor of Dental Surgery, and at least 1 year of work experience in the current position and were willing to participate, in the city of Mangalore, Karnataka were included in the study. As there was no available data on the number of dentists in Mangalore nor the prevalence of carpal tunnel syndrome in the city of Mangalore, the data for all the available dentists were taken into consideration.

Ethical committee clearance was obtained prior to the study. A universal sample of all available subjects was selected for the study. Informed consent was obtained from the subjects and the study was done between July 2011 and September 2011.

Individual characteristics and work history included questions on age, anthropometry, gender, family situation, level of education, duration of employment, and previous jobs. A self-assessment questionnaire for the initial assessment of patients presenting with symptoms of CTS was used for the study. The questionnaire is based on the work of Levine et al (Levine DW *et al.*, 1993) and has been validated in secondary care for the diagnosis of CTS by Kamath and Stothard**.** (Kamath V ***et al.,*** 2003**)** The questionnaire comprises two parts, namely the Symptom Severity Scale (SSS) and the Functional Status Scale (FSS). In the SSS, there are 11 questions; responses may be scored from one (mildest) point to five (most severe) points. The overall result is the calculated mean of all 11 scores. In the FSS, there are eight questions assessing the difficulty in performing selected activities. The overall score for functional status is calculated as the mean of all eight responses. Thus, a higher symptom severity or functional status score indicates worse symptoms or dysfunction. Prior to the study the questionnaire was tested for comprehensibility and relevance among eighteen dentists who were not included in the study.

### Data management and statistical methods:

Data was analyzed using Statistical Package for Social Sciences (SPSS), version 16.0 (SPSS Inc, Chicago IL). Mean (X) and Standard Deviation (SD) was calculated. The Chi square and Fisher's exact tests were used for comparison of categorical data. The odds ratio and 95% CI were calculated separately for subjects for age, duration of employment, previous jobs and symptoms of carpal tunnel syndrome. A level of significance of 0.05 for two-tailed tests was chosen. Logistic regression analysis was used to develop model relating discrete or continuous risk scales and odds ratio of models were taken to find any association between the variables.

## RESULTS:

A total of 210 study subjects responded out of 228 dental professionals to whom the questionnaire was distributed, with a response rate of 92.1% percent. The mean age of the study subjects was 29.05 years; 124 of them were females (59.1%) and 86 were males (40.9%). A majority of 153 study subjects (74%) were below the age of 32 years. Of the total respondents in the study, 112 (53.33%) were married, and only 29 (13.81%) respondents were not pursuing their masters in dentistry. The mean hours of practice was 4.76 hours (0-12 hours) and average years of practice after their dental degree was 4.86 years, where two of the correspondents were practicing for nearly 40 years. Most of the participants were right handed and with an average Body Mass Index (BMI) of 22. 81(21.78-24.14). Only 3 of the respondents had systemic conditions, out of which 2 reported to have hypertension. Of the 210 total respondents in the study, two respondents reported to have previous surgeries for carpal tunnel syndrome CTS (Table I).

The population prevalence of pain, numbness, and/or tingling in the median nerve distribution was as per the symptom questionnaire and was found to be 20%. A total of 14.2 percent complained of pain, 13 (6%) tingling sensation, 11 (5.2%) complained of loss of their dominant hand and 5 (2.38%) complained of all the symptoms of typical carpal tunnel syndrome CTS. When comparison of the symptoms of carpal tunnel syndrome with age, duration of employment, previous jobs, hours of practice per day was analysed, a significant association was seen with the years of practice and the symptoms of carpal tunnel syndrome ($p < 0.001$) with respect to different strata's for hours of practice (Table II).

The results also indicated that there was no statistically significant association in the other variables and symptoms of carpal tunnel syndrome in the present study.

The odds ratio for symptoms of CTS and the associated factors were determined but none of the above factors demonstrated association. The odds ratios for age of the subjects, years of practice after their graduation and hours of practice per day with the symptoms of carpal tunnel syndrome were 1.067 (0.515-2.210), 1.387(0.571-3.371), 1.196 (0.616-2.324) respectively. Gender-specificity increased as one moved proximally along the upper extremity, a regression model of female to that of lower age had a very significant association with odds ratio of 2.144. The table III summarizes frequency of cases and OR estimate after adjusting the effects of the confounders OR > 1 indicates an increased risk of CTS its significance probability (P), and 95% confidence interval (CI) for each risk condition;

Functional Status Scale

Functional Status Scale for hand and/ or wrist symptoms addressed difficulties caused to the respondents doing specific activities, which forms the functional or effect on quality of life associations.

A total of 15 subjects reported to have difficulty in writing and 14 subjects complained of pain or discomfort when carrying grocery. The other daily activities that were affected most were holding the book (n=8) and least function associated was buttoning of dress (n=3) followed by holding the telephone handle and opening of jar. When an association was sought none of the functions were associated with age, hours of practice and years after graduation of the dentist.

**Table I: Demographic Data**

| Years of practice | Pain (Day + Night) | Numbness (Night) | Numbness (Day) | Tingling sensation | Pain + Numbness | Pain+ Numb-Ness+ Tingling sensation (Day + Night) | |
|---|---|---|---|---|---|---|---|
| **0-5** | 24 | 1 | 0 | 12 | 3 | 1 | |
| **5.1-10** | 2 | 7 | 0 | 0 | 1 | 0 | **P = <0.001 (s)** |
| **10.1-15** | 3 | 3 | 4 | 0 | 0 | 0 | |
| **15.1-20** | 2 | 0 | 1 | 1 | 0 | 0 | |
| **20 and above** | 0 | 0 | 0 | 0 | 0 | 0 | |

**Table II : Association between symptoms of carpal tunnel syndrome and Years of practice**

| | | | |
|---|---|---|---|
| Gender | Male 86 (40.9 percent)<br>Female : 124 (59.1 percent) | | |
| Age (Mean) | 29.05 YEARS Min 23 YEARS<br>Max 67 YEARS | | |
| Hours Of Practice (Per day ) | Hours | Frequency | Percentage |
| | 0-3 | 33 | 16.3 |
| | 4-6 | 97 | 47.8 |
| | >6 | 73 | 36.0 |
| | | | |
| Years Of Practise | Years | Frequency | Percentage |
| | 1 to 4 | 155 | 76.0 |
| | 5 to 8 | 25 | 12.3 |
| | 9 to 12 | 16 | 7.8 |
| | >12 | 8 | 3.9 |

**Table III: Risk Estimate (Odds ratios) for symptoms of carpal tunnel syndrome and various factors associated with carpal tunnel syndrome**

| | Odds Ratio | 95% Confidence Interval | |
|---|---|---|---|
| | | Lower | Upper |
| Age | 1.067 | .515 | 2.210 |
| BMI | 1.018 | .834 | 1.242 |
| Years of practice | 1.387 | .571 | 3.371 |
| Hours Of Practice per day | 1.196 | .616 | 2.324 |

**Table VI: Increased Risk Of CTS And Its Significance Probability (P), And 95% Confidence Interval (Ci) For Each Risk Condition for gender ( for female ) and age**

| | Regression coefficient | Std. Error | 95% Confidence Interval | | Hypothesis Test | |
|---|---|---|---|---|---|---|
| | | | Lower | Upper | Chi-Square | Significance |
| Intercept | .763 | 0.067 | .632 | .894 | 129.749 | **.000** |
| Male | .004 | 0.094 | -.181 | .189 | **.002** | **.968** |

## DISCUSSION:

The present study found a point prevalence of 20 percent of pain, numbness, and/or tingling sensation in the median nerve distribution in the present study, which constitutes the major symptoms of CTS. CTS is a Cumulative Trauma Disorders (CTDs), which are injuries of the musculoskeletal and nervous systems that may be caused by repetitive tasks, forceful exertions, vibrations, mechanical compression (pressing against hard surfaces), or sustained or awkward positions. Cumulative trauma disorders are also called regional musculoskeletal disorders; repetitive motion disorders (RMDs), overuse syndromes, repetitive motion injuries, or repetitive strain injuries. These painful and sometimes crippling disorders develop gradually over periods of weeks, months, or years.

CTS is usually diagnosed on the basis of numbness, tingling and pain in the distribution of the median nerve in the hand. It typically is worse at night and with repetitive activity. (Hamann C *et al.,* 200) It is also caused by constant grips or repetitive injury of the median nerve, which is positioned under the flexor retinaculum of the hand next to the wrist. Repetitive hand grips demanding high precision, with the elbows bent, the shoulders often abducted, and the cervical spine flexed and rotated, characterize the work of the dentist. Changes in the osteo-articular system of the hand may arise mainly as a result of local vibrations at frequencies below 30 Hz. The cascade of peripheral nerve changes due to compression includes impaired microcirculation with increased vascular permeability, decreased venous return causing oedema, and subsequent increased endoneurial fluid pressure. In persistent cases, structural changes with segmental demyelination, fibrosis and Wallerian degeneration develop. Hence the synergistic effect of vocational risk factors present in the dentist increases the chances of CTS in this occupational cohort.

The instrument used in present study, the Boston Carpal Tunnel Questionnaire (BCTQ), also referred to as the Levine scale, Brigham and Women Carpal Tunnel Questionnaire and Carpal Tunnel Syndrome Instrument, is a patient-based outcome measure that has been developed specifically for CTS. It has two distinct scales, the Symptom Severity Scale (SSS) which has 11 questions and uses a five-point rating scale and the Functional Status Scale (FSS) containing 8 items which have to be rated for degree of difficulty on a five-point scale. (Leite *et al.,* 2006) BCTQ is a Instrument which measures patient-based outcomes, that has been developed specifically for patients with CTS. The BCTQ has been used as an outcome measure in clinical studies, and has also undergone extensive testing for validity, reliability and responsiveness for knowing the prevalence of CTS.[15] This may the first venture in which the above mentioned instrument is used for exploring the prevalence and association of symptoms of CTS and functional assessment among dentists in the Indian subcontinent.

The present study found a point prevalence of 20 percent of pain, numbness, and/or tingling sensation in the median nerve distribution. This results are in unison with the studies of Hamann *et al.,* 2001, Stenz *et al.,* 1994 and Ghoussoub *et al.,* 2005 which evaluated the symptoms of carpal CTS in the dental professionals, but comparatively lower to that of the studies of Anton *et al.,* 2002 and Fish *et al* in 1998, Lalumandier *et al.,* 2004and Werner *et al* in 2002 and Purine *et al* in 2008. The difference in the results may be attributed to difference in the methodology of the studies, specifically the use of different instruments and symptoms to assess the same. The case definition of CTS is a major give away in these matters, as to what definitely constitutes screening for CTS will still be a matter of great debate.

It has been of highest concern that certain occupational activities carry an increased risk of CTS, especially involving highly repetitive or forceful movements of the hands, and 'strong evidence' in relation to the combination of these exposures. This should prompt dental professionals with CTS-type symptoms to educate themselves on all possible etiologies to avoid unnecessary surgery or ineffective therapies, as the prevalence of CTS in general population ranges from 1-2%, which is comparatively very low. (Morse TF et al., 2003)

The association between the factors associated with CTS and age, BMI, gender, family situation, level of education, duration. of employment, previous jobs and hours of practice interestingly did not show any association but years of practice after completing their degrees showed a significant association between the different age groups. This is similar to the studies of Hamman *et al.,* 2001, Morse et al., 2003

which may be due to the fact that the development of CTS is based on years of exposure to repetitive and forceful work. CTS has a high female predilection as they have shown to have smaller wrists and potentially smaller carpal canal volumes. (Ghoussoub *et al.,* 2005) In the study by Atroshi *et al* in 1999, a prevalence of 3.0 percent as against 2.1 percent in women to that of men was observed. Stevens and colleagues found the incidence rate to be three times higher among women, especially in the 50- to 70-year-old age group. (Hamman *et al.,* 2001) As female dentists in the present study were much younger hence the estimation of the prevalence among dentists may underrepresent women.

There have been significant findings in literature that correlates to body mass index (BMI) and CTS but the present study did not find any association between them. Descatha *et al.,* 2004 found obesity as the most common factor associated with the risk of CTS (29 % vs 7 %) of subjects and Werner et al found that median mononeuropathy at the wrist was 2.5 times more likely to occur in those individuals classified as obese (BMI > 29) when compared to individuals with BMI < 20, Lam N *et al* 1998, found a higher incidence of CTS in subjects with higher BMI. The mean BMI of respondents in the present study is 22.81 which translates into normal BMI, might be the reason for such non-association.

The functional status of the respondents very much reflected on their quality of life with CTS and can have a significant impact on quality of life. Pain or muscle weakness may prevent a person from doing important tasks at work, forcing them to choose another occupation. These symptoms may also affect a person's hobbies, or even everyday activities like driving, writing, buttoning of clothes, doing household chores etc.

The design of the present study was cross-sectional, and a potential source of error thus is the "healthy worker effect" i.e., dentists who had given up clinical dentistry because of symptoms were not accessible for the study. The participating dentists were not drawn to the study owing to hand symptoms but participated in general. Our expectation was that more dentists with hand symptoms would participate in the CTS screening and lead to an overestimation of prevalence. While a random sample and longitudinal study of dentists would be ideal to assess true prevalence and incidence. Electro diagnostic evaluation was not performed in the present study and the questionnaire was used without the hand diagrams. Hence our sample population may underestimate the condition's true prevalence.

The activities of dentists screened in the present questionnaire were non-specific to dentistry as a profession per se, due to an array of other gadgets such as laptops, mobiles and associated hobbies and passions such as driving, gardening and gaming may have expand the scopes of the symptoms or exaggerate the symptoms in dental professionals. More ever sports activities and related injuries might add a different avenue to the symptoms of the disease, and was not included in the questionnaire. The above mentioned activities are potential risk factors in enough detail to define any additional risk or protective role these activities may have had in defining the syndrome in the study population.

Increased risks have been observed in females than in males with an odds ratio of 2.144, because of, hormonal factors, both endogenous and exogenous, which may account for some of the differences in the frequency of CTS between men and women, including use of the Pill in women and obesity. (Hagberg *et al.,* 1992)

## Conclusions:

From the present study we conclude that the prevalence of CTS in dental professionals is high, that is 20%, of which 14.2% complained of pain. This had a direct relation to the years of practice of the dental professional, when the diagnosis is made using symptom severity scale. However, there appears to be no significant difference between the prevalence of symptoms CTS among dentists and age, BMI, gender, family situation, level of education, duration of employment, previous jobs and hours of practice of the subjects. Further studies are needed to confirm the present results with the use of electro diagnostic procedures and hand diagrams taking into account the possible synergistic effect of workload, vibrations use of other gadgets and sports related activities.

Regardless of the etiology of hand/wrist pain, dental professionals should realize that their occupation is a perpetuating factor for the development of this pain. Prevention is of great importance, and intervention strategies should become an integral habit in the operatory in the office and at home.

## Recommendations:

1. Early recognition of symptoms and education regarding ergonomic risk factors is important in the successful management of CTS.
2. Use of separate questionnaire for dental professionals for both the hands as flexion of wrists and effects of vibration is felt in both the hands as most questionnaire are limited to only to a single hand or the dominant hand.
3. Proactive management of people at risk of developing CTS or experiencing pain is a as in some occupational cohorts such as dentists might be a reasonable approach to reducing the risk of future development of CTSs.

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