Carpal Tunnel Syndrome: Risk Factors among Hand Therapists

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CARPAL TUNNEL SYNDROME: RISK FACTORS AMONG HAND THERAPISTS

by

Suzanne Makielski

A Thesis Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Master of Science Department of Occupational Therapy

Western Michigan University Kalamazoo, Michigan December 1993
The following study examined the presence of risk factors among hand therapists for developing carpal tunnel syndrome. A review of the literature indicated a significant relationship between the incidence of carpal tunnel syndrome and manual workers whose occupational tasks involve repetitive wrist and hand movements. Hand therapists were characterized as manual workers while possessing specialized knowledge and skill in the evaluation and treatment of hand and wrist disorders. Biomechanical analysis of various "hands on" techniques revealed repetitive wrist and hand movements including the use of force and increased risk for injury associated with carpal tunnel syndrome. In order to determine the significance of the problem, a survey method was used. Questionnaires were sent to 430 members of the American Society of Hand Therapists. Data analysis involved a percentage profile and z score with final acceptance or rejection of the null hypothesis.
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Carpal tunnel syndrome: Risk factors among hand therapists

Makielski, Suzanne, M.S.
Western Michigan University, 1993

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CHAPTER I

INTRODUCTION

The following study examined the presence of risk factors among hand therapists for developing carpal tunnel syndrome using a survey questionnaire. Participants were members of the American Society of Hand Therapists. In a review of the literature, numerous studies indicated a significant relationship between the occurrence of carpal tunnel syndrome and manual workers whose occupations involved repetitive wrist movements and grasp. Additional contributing factors included the use of force during manual tasks, work pace, stress and increased activity levels. Corrective measures of providing education regarding proper body mechanics and job design according to ergonomic considerations were highlighted.

Hand therapists, including both occupational and physical therapists, were characterized as manual workers while possessing specialized knowledge and skill in the evaluation and treatment of various hand and upper extremity disorders. A biomechanical analysis revealed repetitive wrist flexion, extension, deviation and prehension during the implementation of therapeutic techniques and modalities. Many therapists
favored a "hands on" approach which under certain circumstances led to increased risk for injury. In order to determine the prevalence of carpal tunnel symptoms among hand therapists, data analysis involved a percentage profile and z score with final acceptance or rejection of the null hypothesis. Nevertheless, continued study of carpal tunnel syndrome and other cumulative traumas was needed with formal follow-up of workers who underwent steps toward prevention to determine usefulness.

Rationale

The purpose of this study was to identify possible risk factors among hand therapists for developing carpal tunnel syndrome. A review of the literature indicated a relationship between the occurrence of carpal tunnel syndrome and manual workers whose occupations involved repetitive wrist movements and grasp. Some studies (Masear, Hayes & Hyde, 1986; Sebright, 1986; Feldman, Travers, Chirico-Post & Keyserling, 1987; Armstrong, Fine, Goldstein, Lifshitz & Silverstein, 1987) suggested biomechanical influences of work-related tasks contributed to this disorder and also raised questions about modification of tasks for prevention. Key factors for analyzing the presence of occupational hazards included repetitive wrist flexion, extension, deviation and grasp. Additional factors included force, work pace, stress and increased activity levels.
Armstrong et al. (1987) studied 652 workers from seven work sites, each from four combinations of force and repetitiveness. Workers' occupations included electronics, sewing, appliance, bearing fabrication, bearing assembly and investment molding plants. The combinations of force and repetitiveness were broken down into high-repetitive, low-repetitive, high-force and low-force. A cross-sectional study was performed to evaluate the relationship between repetitiveness, forcefulness and selected cumulative trauma disorders of the hand and wrist. The results demonstrated a significant correlation between signs and symptoms of the wrist and hand and the repetitiveness and forcefulness of manual work. These researchers concluded that although there was a significant relationship between repetitiveness, forcefulness, and symptoms of wrist and hand tendonitis among manual workers, further follow-up for job modification and preventive design as needed.

In a study by Feldman, Travers, Chirico-Post & Keyserling, (1987), a walk-through visit and survey, biomechanical analysis, and neurological evaluation were made involving 586 employees of an electronic assembly plant. All of the employees were surveyed via questionnaire including demographic information and past medical history. Of the 586 employees, 84 were identified in high-risk work areas. Two subjects were randomly selected for biomechanical analysis from each of the four high-risk areas, determined by frequency of complaints on survey questionnaire and walk-
through observations of tasks involving repetitive wrist flexion, extension, pinching and deviated wrist postures. Individual workers were filmed while performing job tasks for the purpose of biomechanical analysis. These researchers reported that hand and wrist symptoms were more prevalent in the high-risk group (17.9%) as compared to the remaining population (8.7%). In addition, symptoms of pain, numbness and tingling in the fingers, and frequent complaints of inability to unscrew bottle caps appeared parallel to ergonomic factors according to job tasks in each of the high-risk areas. This study established a structural approach to worker surveillance and emphasized the need to take actions toward reducing the risks associated with carpal tunnel syndrome. Recommendations for ergonomic adjustments for workers with early stages of carpal tunnel syndrome in high-risk areas were provided.

In a retrospective study by Masear, Hayes & Hyde (1986) involving 788 employees of a meat packaging plant between 1967 and 1983, an incidence of 14.8% of carpal tunnel release surgery before 1983 was found. Twenty percent of female employees and 14.5% of male employees had at least one carpal tunnel release. Workers that performed ham-boning and loin-boning were found to have significant rates of carpal tunnel surgery as well (20% and 17% respectively). Masear et al. (1986) reported extremes of wrist movements, especially wrist flexion and ulnar deviation as primary repetitive movements for those workers. It was concluded that repetitive
trauma or overuse may be the etiologic agent of carpal tunnel syndrome in the meat packaging industry and that means for possibly decreasing the incidence of CTS might include rotation of jobs so that more strenuous work was not always performed by the same employees. The meat packaging industry was first to be identified by Elizabeth Dole, then Secretary of Labor, for the recently implemented regulations by the Occupational Safety and Health Administration (OSHA).

In summary, the incidence of carpal tunnel syndrome among workers involved in repetitive manual tasks caused serious concern, one which raised questions about identifying other high-risk jobs with recommended changes for preventive measures. Other contributing factors in the development of cumulative trauma disorders including carpal tunnel syndrome were studied by Arndt (1987) in the article 'Work pace, stress, and cumulative trauma disorders.' The author discussed the potential roles of work pace and work pressure contributing to tendonitis, tenosynovitis and carpal tunnel syndrome in workers performing highly repetitive tasks. Specifically, Arndt (1987) observed how increased work pace was accompanied by increased muscular effort via EMG recordings. Likewise, other investigators (Lundervold, 1951; Laville, 1968; Teiger, 1978 and Levi, 1972) reported increased EMG activity when speed was increased during such activities as typing and industrial tasks. As noted by Arndt (1987) and Welch (1972), work pressure was found to produce tension in
individuals via machine pacing and wage incentives as well as foregoing breaks or working overtime to increase earnings. These conditions contributed to increased tension in the muscles of the forearms. The sample population for this study was small and therefore sufficient conclusions about all potential risk factors could not be made. However, individual workers reported discovering and appreciating how pacing impacted the onset of musculoskeletal injuries. Again, job design was key to analyzing how it affected job pressures. The application of ergonomic principles in job design deserved attention.

Ergonomics, or human factors engineering, provided information and knowledge so that workers and machines, or things could interact in a safe and effective manner. This approach was considered and, in some cases, implemented in the prevention of wrist and hand injuries. As mentioned by John D. Benson, PE, CSP, PCMH (1986) in the article, 'Use of ergonomics to prevent handling injuries at the workplace,' when repetitive motion injuries or potential causes were identified, actions to possibly mechanize operations were considered. Jobs were then designed to promote performance with the wrist in a neutral position. Also, steps to reduce excess pressures including grip, pinch, palm torque and muscular effort were made. Adjustments were provided for work height, reaching, posture, and fatigue. Despite research studies (Feldman et al., 1987; Sebright, 1986; Fine, Silverstein, Armstrong, Anderson & Sugano, 1986; Arndt, 1987 and
Masear et al., 1986) that affirmed a significant relationship between repetitiveness, forcefulness and symptoms of wrist and hand tendonitis, the usefulness of job design has yet to be empirically evaluated including systematic follow-up of workers. However, most researchers agreed that this approach was the key towards prevention of cumulative trauma disorders including carpal tunnel syndrome.

In a satellite teleconference seminar sponsored by the National Safety Council (May, 1984, p.4), cumulative trauma was defined as "the willful or unconscious abuse of the hands through job-related or recreational activities resulting in injury over a period of time." The most common form being that of carpal tunnel syndrome. Causes of this and other cumulative trauma disorders within the industrial setting were categorized according to the following: (a) improper production lines, (b) improper tools, (c) inadequate training of personnel in proper body mechanics, and (d) disregard for machine standards and safety policies.

In a retrospective study by Masear et al. (1986) of 788 employees of a meat packaging plant, compensation claims and days lost from work amounted to costs in excess of 1 million dollars in a 5 year period. Lost work days ranged from 7 to 285 with an average of 53.6 days lost from work per hand. Disability ratings ranged from 5% to 35% with an average 18% given per hand. Average workers' compensation claims were figured at $1848 per hand. Settlement costs averaged at $8273 per hand. Additional
costs, not added to these figures, included hospital costs and physician fees. According to the 1982 Michigan Annual Survey of Occupational Injuries and Illnesses, 35% of OSHA recordable occupational illnesses in the private sector were due to repeated trauma compared to 6% in the public sector. A more recent report by the Centers for Disease Control estimated 47 percent of carpal tunnel cases were work-related, based on physician reporting as noted by Franklin, Haug, Heyer, Checkoway and Peck (1991) in a study of occupational carpal tunnel syndrome in Washington State. In light of these findings, the need for further investigation of workers, in this case hand therapists, was made clear for the author.

In the field of rehabilitation medicine, both occupational and physical therapists working in physical dysfunction decide on career paths of specialty areas of practice. One of these is the area of hand therapy. Hand therapists evaluate and treat a variety of conditions affecting the hand and upper extremity. Much of this work involves a "hands on" approach to therapeutic intervention and requires manual work, in addition to specialized knowledge and skill. These skills involve the use of one's hands for implementing therapeutic techniques such as massage, passive stretching and range of motion exercises, joint mobilization, splint design and fabrication, ultrasound and other electrical modalities. All of these tasks involve wrist and hand movements which include varying degrees of forcefulness and are considered repetitious, especially if a therapist's
caseload is significant in numbers with patients who share common disorders.

A biomechanical analysis of such manual and modality treatment techniques revealed the presence of joint stresses caused by compression resulting from deviated wrist postures and grasp in combination with applied forces in varying degrees. As noted by Smith, Sonstegard, & Anderson (1977) and Tanzer (1959), the result of these movements was compression on the median nerve leading to carpal tunnel syndrome if performed repeatedly over time. It was therefore hypothesized that there was a relationship between the incidence of carpal tunnel syndrome among hand therapists and the presence of risk factors or occupational hazards.

In reviewing the literature, it was important for the author to examine the presence of such working conditions among hand therapists and to evaluate the need for job modification and further education and training in proper body mechanics for the purpose of prevention. Factors of work pace and stress characterizing a person's work habits demonstrated increased risk for musculoskeletal symptoms (Arndt, 1987). Ultimately, ramifications for organization and structure were realized, i.e. the need for mandated job modifications in methods of practice. Furthermore, education in proper body mechanics and joint protection as well as ergonomic considerations were essential and integral aspects of prevention. In addition, if early reporting was encouraged, identification of control factors
and improved prevention efforts could better prevent progression to lost-time illness, workers' compensation and unnecessary surgery (Silverstein, 1991). The following study attempted to highlight possible risk factors among hand therapists for developing carpal tunnel syndrome and how this problem might be addressed through further research efforts and continuing education.

Research Question

Is there a relationship between the incidence of carpal tunnel syndrome among hand therapists and the presence of occupational hazards?

Definition of Terms

Biomechanics was defined in this study as the mechanism of biological or muscular activity (Oxford University Press, Inc., 1980).

Biomechanical approach was defined in this study as the method used to treat deficits secondary to sudden cumulative trauma or disease affecting the musculoskeletal system, spinal cord, or peripheral nervous system (Williams & Wilkins, 1989).

Acupressure was defined in this study as the application of pressure to a trigger point found in muscle for alleviation of tension and pain (Upledger, 1985).
Body mechanics was defined in this study as the principles of good joint alignment, the use of large muscles instead of small and working in harmony with gravity (Williams & Wilkins, 1989).

Force was defined in this study as an agent or influence applied to a free body resulting in acceleration of the body and sometimes in elastic deformation or other effects (Oxford University Press, Inc., 1980).

Joint mobilization was defined in this study as passive movements done at such a speed that the patient could prevent them if he chose (Williams & Wilkins, 1989).

Massage was defined in this study as the manipulation of tissues (as by rubbing, stroking, kneading, or tapping) with the hand or an instrument for remedial or hygienic purposes (Oxford University Press, Inc., 1980).

Manual therapist was defined in this study as anyone in a healing profession who uses their hands as therapeutic tools (Upledger, 1985).

Occupational hazard was defined in this study as a risk of accident or illness associated with a certain job (Oxford University Press, Inc., 1980).

Splinting was defined in this study as the design and fabrication of thermoplastic splints or devices added to a person's body to support, position, or immobilize a part (Williams & Wilkins, 1989).
CHAPTER II

LITERATURE REVIEW

The following literature review was divided into three categories: (1) definition of carpal tunnel syndrome, (2) etiology, and (3) investigation of hand therapists.

Definition of Carpal Tunnel Syndrome

Carpal Tunnel Syndrome (CTS) is a condition caused by compression of the median nerve as it traverses the wrist along with the flexor tendons of the fingers. Compression occurs when there is a decrease in tunnel space, enlargement of the median nerve, or increased volume of contents in the carpal canal (Bleeker, 1987). As a result, movements of the tendons and nerve are impeded from naturally occurring smoothness and glide (Groneman, 1985). Symptoms of CTS include pain, numbness or tingling in the hand and fingers, decreased grip strength, decreased dexterity and eventual loss of function in the hand if untreated. Treatment may range from splinting, anti-inflammatory agents, modification of activities to surgical release of the transverse carpal ligament if the conservative measures fail to alleviate symptoms.
Etiology

The etiology of carpal tunnel syndrome is linked to burns, fractures, diabetes, pregnancy, rheumatoid arthritis, osteoarthritis, polyneuropathy, tumors and other systemic diseases. Causal factors for developing carpal tunnel syndrome include performance of repetitive manual tasks particularly those involving pinch and grasp during wrist flexion, thereby compressing the median nerve against the transverse carpal ligament (Reinstein, 1981). Abnormal posturing or deviation of the wrist from the neutral position can compress the median nerve as well (Sebright, 1986). Studies by Smith, Sonstegard, & Anderson (1977) and Tanzer (1959) found that pressure within the carpal tunnel increased when the wrist was flexed or extended. It was reported that CTS was between two and ten times more common in women than in men (Armstrong & Chaffin, 1979).

Tendon force involving the flexor digitorum profundus tendons of the 2nd and 3rd digits was identified as a causal factor in the development of carpal tunnel syndrome (Smith et al., 1977). A study of 652 workers from seven work sites revealed high-repetition and high-force jobs placed workers at risk for wrist and hand tendonitis with a significantly higher incidence of tendonitis found among those workers in such jobs (Armstrong, Fine, Gold-stein, Lifshitz & Silverstein, 1987). In the event of wrist and hand tendonitis, CTS may result from compression caused by increased volume
of contents in the carpal canal and decreased tunnel space due to this inflammatory process. As Armstrong et al. (1987) reported,

Tendons function as mechanical links that transmit forces, stabilize movements, and move the kinematic chains of the extremities. As a result, tendons are subjected to tensile stresses by the muscle and to compressive and shearing stresses from adjacent bones and ligaments...Tendons respond mechanically to these stresses by becoming deformed. (p 833)

Furthermore, physiologic responses occur that involve metabolic, circulatory and adaptive changes. These changes include thickening, proliferation of fibrocytes and fibrous connective tissue, destruction of synovial membranes, and adhesions. Thus, stresses on tendons may be transferred to adjacent structures such as nerves (Armstrong, Castelli, Evans & Diaz-Perez, 1984; Lamphier, Crooker & Crooker, 1965; Muckart, 1964; Phalen, 1966 and Yamaguchi, Lipscomb & Soule, 1965). Such is the case of the long finger flexors compressing on the median nerve and resulting in carpal tunnel syndrome. During wrist flexion, the flexor tendons impinge on the median nerve while opening and closing the hand, or fist, causing them to rub on the nerve. Tissues, i.e. tendons and tendon sheaths, are adaptive to mechanical stress but nerves are not. However, if the stresses are significant over time, then trauma occurs. Disorders of tendons and tendon accessory tissues were identified as major occupational health problems (Arndt, 1987; Chapnick & Gross, 1987; Armstrong et al., 1987; Fine, Silverstein, Armstrong, Anderson & Sugano, 1986; Delgrosso & Boillat,
1991) and if unchecked could lead to chronic nerve disorders like carpal tunnel syndrome. Such disorders were identified as cumulative trauma disorders (Fine et al., 1986).

In review, carpal tunnel syndrome is considered to be part of a broad category of cumulative trauma disorders whereby damage occurs over time as a result of repeated exposures to certain stressors namely, long term, repetitive motions of the wrist and hand. The onset of symptoms may be slow but can ultimately be debilitating. Hand dominance was found to be a contributing factor to carpal tunnel syndrome due to greater activity and repetition in comparison to the non-dominant hand (Reinstein, 1981; Nathan, Doyle & Meadows, 1986 and Bleeker, 1987).

Typically, cumulative trauma disorders are studied in relation to occupational health problems such as noise-induced hearing loss, lung disease and occupational cancers which are routinely under surveillance by occupational health programs. As noted by Fine et al. (1986), only some occupational health disorders could be detected in the presymptomatic state. However, cumulative trauma disorders such as carpal tunnel syndrome might not be identified until symptoms are acute and interfere with one's ability to successfully engage in work activities. The primary task of occupational safety programs then becomes focused on early detection of work-related illnesses and prevention, not just treatment. A team approach between safety and medical management and the use of meaningful
information such as diagnosis might prevent the expansion of these medical conditions in the future (Bleeker, 1991).

Barnhart & Rosenstock (1987) reported that workers with similar workplace exposures who demonstrated a high incidence of carpal tunnel syndrome like meat cutters, seamstresses, grocery checkers, typists, construction workers and electronic assembly workers, signaled the presence of a work-related illness or disorder. Barrer (1991) reported that, according to the U.S. Department of Labor, the percentage of repetitive-motion disorders had risen to 48% of all occupational injuries in 1989, up from 18% reported nine years ago.

During the Employment and Housing Sub-committee of the House of Government Operations Committee held on June 6, 1989, the alarming rate of repetitive motion disorders was discussed. One speaker, Barbara Silverstein, PhD of the University of Michigan, reported the findings of a survey by the California Department of Health Services in which providers reported 7,214 cases of CTS during 1987 and approximately 3,413 cases were work-related. However, normal channels reported only 71 cases. In reality, 50 times more work-related cases of CTS were going unreported (PT Bulletin, 1989). Another speaker, Martin Bahr, president of the Communication Workers of America, commented on a survey by the Bureau of Labor Statistics which showed that repetitive motion disorders were now
the single largest cause of occupational illnesses, replacing skin diseases (PT Bulletin, 1989).

It has been estimated that companies with high risk for worker injury due to repetitive motion will spend $250,000 per year, per 100 employees (Barrer, 1991). Obviously, carpal tunnel syndrome as a work-related illness was found to be of paramount concern requiring needed attention in the private and public sectors. In a study by Delgrosso and Boillat (1991), the relationship between occupations involving repetitive wrist and hand movements and the onset of carpal tunnel syndrome was strongly supported. In addition, women were identified at greater risk for developing CTS in such occupations. Measures to identify high-risk workers for carpal tunnel syndrome and other cumulative trauma disorders are becoming focused upon in light of increased awareness and steps toward prevention. This calls for on-going analysis of occupations requiring repetitive manual activities for possible risk factors. One such occupation to be explored was hand therapy.

Investigation of Hand Therapists

As defined by Phillips (cited in Trombly, 1989) a hand therapist is one who possesses an "intimate knowledge of normal hand anatomy and must adhere to basic principles of wound healing to determine choice and timing of basic therapeutic modalities." (p 512) The use of orthoses in
treatment is based upon biomechanical principles of splinting to ensure fulfillment of its purpose. The therapeutic process begins with evaluation by the hand therapist and then determination of an appropriate course of treatment. Treatment may consist of modalities such as thermal application, ultrasound, phonophoresis, or other electrical modalities, splinting, massage and therapeutic exercise. Conditions treated include joint injuries, joint implant arthroplasty, peripheral nerve injury, tendon transfers, tendon repair, tenolysis and finally cumulative trauma disorders. In essence, hand therapists utilize their hands for nearly all aspects of evaluation and treatment, making the nature of their work manual indeed. As hand therapists practice over a period of time, treating significant numbers of patients while performing manual tasks involving wrist flexion, extension, and deviation as well as grasp, cumulative trauma in the form of carpal tunnel syndrome may result.

In recent years, the growing interest and popularity of manual therapy techniques which promote a "hands on" approach to therapeutic intervention include joint mobilization and soft tissue techniques such as acupressure and myofascial release. Both of these techniques involve applying force in varying degrees using one or more of the digits in a partially or fully extended position and the base of the palm with the wrist extended. Ultimately, compression of joint surfaces and surrounding tissues results. Again, as noted by Meagher (1987), excessive pressure or
movements performed in a unit of time over a period of time would result in pathologic changes in tissues. The performance of these occupational tasks may result in unusual pressure on bony prominences, tendons, muscles and nerves thereby resulting in the onset of carpal tunnel symptoms.

Further analysis of treatment techniques employed by hand therapists revealed the combination of thermal application, electrical modalities, splint fabrication and massage as possible occupational hazards. A biomechanical overview of these occupational tasks reveals wrist flexion and pinch grasp during retrieval of thermal packs from a hydroculator machine; wrist flexion, ulnar deviation and palmar grasp during ultrasound or phonophoresis; wrist extension, flexion, deviation and grasp during massage and finally, wrist flexion, extension, deviation and grasp during splinting. As previously reported, abnormal posturing or deviation of the wrist from the neutral position can compress the median nerve (Sebright, 1986). Arndt (1987) described these mechanisms of repetition which increased intra-tunnel pressure causing trauma to the nerve directly while increased activity levels that exceeded the lubricating capacity of the flexor sheath with subsequent friction, inflammation of the tendon sheath, and swelling caused secondary compression of the median nerve. It becomes clear that manual skills performed by a hand therapist are potentially hazardous if performed repeatedly over time. This may be true for the hand
therapist who works full-time treating clients with similar disorders. Additional factors such as work pace, stress and ergonomic considerations suggest increased risk for experiencing carpal tunnel symptoms (Arndt, 1987).

Based upon review of the literature, there is no evidence of investigation directed to possible occupational hazards among hand therapists. The preponderance of industrial and clerical workers in the general population makes it easier to conduct research with more appreciable and obvious impact. Hand therapists are much fewer by comparison and make up a small proportion of workers. However, they do perform repetitive manual tasks and under certain circumstances may be involved in highly repetitive and forceful movements. Hence, carpal tunnel syndrome may develop as described in the literature.

In view of increased awareness and steps toward prevention, continued efforts are needed in identifying workers at risk. An investigation of hand therapists was made since they too characterize manual workers despite possessing specialized knowledge and skill. Possible occupational hazards were identified by the use of therapeutic "hands on" techniques and modalities. No previous study of this group and carpal tunnel syndrome was found which incited the need for such a study. A survey of hand therapists with identification of risk factors was made to determine the significance of the problem among hand therapists.
Hypotheses

Conceptual

1. There is a relationship between the incidence of carpal tunnel symptoms among hand therapists and the presence of occupational hazards.

2. There is a relationship between the presence of contributing factors and incidence of carpal tunnel symptoms among hand therapists.

Operational

1. The incidence of carpal tunnel symptoms among hand therapists is greater than or equal to that of industrial workers.

2. For hand therapists, the presence of contributing factors is dependent of the symptoms of carpal tunnel syndrome at .05 level of significance.

Null

1. The incidence of carpal tunnel syndrome among hand therapists is less than that of industrial workers.

2. There is no relationship between the presence of contributing factors and the symptoms of carpal tunnel syndrome among hand therapists.
CHAPTER III

METHODOLOGY

The methodology used in this study involved a survey research design using a mailed questionnaire to 430 hand therapists. Subjects were chosen based upon membership in the American Society of Hand Therapists. The purpose of the questionnaire was to determine the predominant methods of practice used by hand therapists and the presence of carpal tunnel syndrome symptoms. Those individuals with significant medical histories were omitted in order to control for confounding results.

Subjects

The population used in this study consisted of certified hand therapists including both occupational and physical therapists (430) who were members of the American Society of Hand Therapists as of January 1990. Ninety-two percent (394) were female and eight percent (36) were male. Demographic information on age was not available. The entire population was surveyed.
Instrument

The questionnaire was developed by the author and included both closed and open-ended questions. The focus of the items was based on the literature review in determining the incidence of carpal tunnel symptoms and the presence of contributing factors. The types of tools and modalities used in one's job and the frequency of use was explored as well as splinting methods. Those surveyed were asked to indicate personal medical histories, present symptoms of carpal tunnel syndrome, severity of symptoms, when the symptoms occurred and warning signs exhibited. The presence of other factors such as stress and high physical demands at work were investigated as well. Medical treatment and lost days from work due to carpal tunnel symptoms were examined. Additional comments or observations were asked for upon completion of the questionnaire.

Procedure

The procedure involved mailing number coded questionnaires to each individual member of the American Society of Hand Therapists. Each person was sent a cover letter (Appendix A) and questionnaire (Appendix B) including instructions for completion and response deadline. A self-addressed, self-stamped envelop was provided as well. A follow-up letter was sent to those who failed to respond within the suggested time frame as
a friendly reminder. Those who showed positive medical histories for conditions predisposing one to developing carpal tunnel syndrome were eliminated. These conditions included rheumatoid arthritis, upper extremity fracture, tumors, pregnancy (presently), polyneuropathy, diabetes and/or other systemic diseases, hysterectomy and symptoms related to avocational activities. Upon receipt of each response, all data was collected and recorded. Data analysis involved the determination of significant findings supporting the hypothesis of this study.

Data Analysis

Analysis of the collected data was made using a percentage profile to determine if a significant proportion of hand therapists reported carpal tunnel symptoms secondary to performing repetitive manual job tasks. A final z score was obtained. An alpha of .05 allowed for rejection of the null hypothesis. A chi square analysis for independence was conducted to determine if those variables that contribute to the incidence of carpal tunnel symptoms were significant. An alpha of .05 was used to reject the null.
CHAPTER IV

RESULTS

Fifty-seven percent of 430 questionnaires distributed were returned (n=246). Seventy-nine questionnaires were not included in the data analysis because of positive medical histories or symptoms related to avocational activities. Results were based on the remaining 167 questionnaires. Ninety-two percent (n=155) of the subjects who responded to the survey were female while 8% (n=12) were male. Ages of the respondents ranged from 27 to 59 years with a mean age of 35.85. Surveys were screened for significant medical histories in order to control for confounding results. Subjects were comprised of 135 occupational therapists, 29 physical therapists and 3 OT's/PT's. Work status included 50 part-time and 117 full-time.

An average daily caseload of 5-8 clients was reported by 23% of hand therapists while 36% reported 9-12 clients and 25% reported an average daily caseload of 12-16. Sixteen percent of hand therapists reported an average daily caseload of more than 16 clients. Splinting performed by the therapist was reported by 165 subjects. Nine reported splinting performed by an assistant as well. Of those 9, one reported that the therapist
performed the actual molding after the assistant cut-out the splint pattern. Splinting method was characterized as custom-made, preformed and prefabricated. One hundred twenty-three (74%) subjects reported the primary splinting method as custom-made while 40 (24%) reported a combination of custom-made, preformed and prefabricated. Four (2%) respondents reported no splinting performed on the job.

Tables 1 and 2 summarize the various types of modalities and tools used in one's job. The most frequently used modalities reported were thermal packs (68%) and electrical stimulation (65%). The modalities utilized least were casting (1%), manual resistance (2%) and debridement/dressings (4%). Modalities utilized at least fifty percent of the time were paraffin baths (50%) and ultrasound (51%). The most frequently used tools reported were hammer (92%) and scissors (90%). The tools least utilized were adapted fiskar clippers (.5%), tongs (1%), power screwdriver (1%), keyboard (1%), dynamometer/pinch gauge (1%), and jig (1%). Pliers and hole punch were reported as being used 67% and 52% of the time respectively.

When asked about the frequency of both tool and modality use at work, subjects characterized use as daily, or ≥50% of the time. Seventy-five percent reported daily tool/modality use while 25% percent indicated frequency as ≥50% of the time.
Table 1

Modalities Used in One's Job (n=167)

<table>
<thead>
<tr>
<th>Modality</th>
<th>Responses</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermal packs</td>
<td>114</td>
<td>68%</td>
</tr>
<tr>
<td>electrical stimulation</td>
<td>108</td>
<td>65%</td>
</tr>
<tr>
<td>ultrasound</td>
<td>86</td>
<td>51%</td>
</tr>
<tr>
<td>paraffin baths</td>
<td>83</td>
<td>50%</td>
</tr>
<tr>
<td>fluidotherapy</td>
<td>64</td>
<td>38%</td>
</tr>
<tr>
<td>whirlpool</td>
<td>57</td>
<td>34%</td>
</tr>
<tr>
<td>massage</td>
<td>53</td>
<td>32%</td>
</tr>
<tr>
<td>exercises</td>
<td>29</td>
<td>17%</td>
</tr>
<tr>
<td>joint mobilization</td>
<td>25</td>
<td>15%</td>
</tr>
<tr>
<td>BTE</td>
<td>23</td>
<td>14%</td>
</tr>
<tr>
<td>iontophoresis</td>
<td>24</td>
<td>14%</td>
</tr>
<tr>
<td>biofeedback</td>
<td>18</td>
<td>11%</td>
</tr>
<tr>
<td>PROM</td>
<td>17</td>
<td>10%</td>
</tr>
<tr>
<td>CPM</td>
<td>16</td>
<td>9%</td>
</tr>
<tr>
<td>vibration</td>
<td>13</td>
<td>8%</td>
</tr>
<tr>
<td>jobst pump</td>
<td>13</td>
<td>8%</td>
</tr>
<tr>
<td>contrast baths</td>
<td>12</td>
<td>7%</td>
</tr>
<tr>
<td>work hardening</td>
<td>9</td>
<td>6%</td>
</tr>
<tr>
<td>debridement/dressings</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>manual resistance</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>casting</td>
<td>2</td>
<td>1%</td>
</tr>
</tbody>
</table>
## Table 2

### Hand Tools Used in One's Job ($n=167$)

<table>
<thead>
<tr>
<th>Tools</th>
<th>Responses</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>hammer</td>
<td>153</td>
<td>92%</td>
</tr>
<tr>
<td>scissors</td>
<td>151</td>
<td>90%</td>
</tr>
<tr>
<td>pliers</td>
<td>111</td>
<td>67%</td>
</tr>
<tr>
<td>hole punch</td>
<td>87</td>
<td>52%</td>
</tr>
<tr>
<td>exacto/utility knife</td>
<td>62</td>
<td>37%</td>
</tr>
<tr>
<td>wire cutters</td>
<td>54</td>
<td>32%</td>
</tr>
<tr>
<td>screwdriver</td>
<td>35</td>
<td>21%</td>
</tr>
<tr>
<td>sheers</td>
<td>21</td>
<td>13%</td>
</tr>
<tr>
<td>tin snips</td>
<td>21</td>
<td>13%</td>
</tr>
<tr>
<td>awl</td>
<td>16</td>
<td>10%</td>
</tr>
<tr>
<td>hand drill</td>
<td>16</td>
<td>10%</td>
</tr>
<tr>
<td>heat gun</td>
<td>15</td>
<td>9%</td>
</tr>
<tr>
<td>eyelet setter/rivet</td>
<td>13</td>
<td>8%</td>
</tr>
<tr>
<td>goniometer</td>
<td>13</td>
<td>8%</td>
</tr>
<tr>
<td>wire benders</td>
<td>8</td>
<td>5%</td>
</tr>
<tr>
<td>allen wrench/BTE wrench</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>vice</td>
<td>7</td>
<td>4%</td>
</tr>
<tr>
<td>wrench</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>debridement tools</td>
<td>7</td>
<td>4%</td>
</tr>
<tr>
<td>bolt cutters</td>
<td>5</td>
<td>3%</td>
</tr>
<tr>
<td>tongs</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>powerscrew driver</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>keyboard</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>dynamometer/pinch gauge</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>jib</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>adapted fiskar clippers</td>
<td>1</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

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Personal medical histories which were not excluded from the study included tenosynovitis and oral contraceptive. Review of the literature had not linked either to the onset of CTS symptoms conclusively.

Twenty-seven subjects reported significant histories for tenosynovitis and 18 reported histories of oral contraceptive use. Fifty-nine (35%) respondents reported CTS symptoms in varying degrees. Table 3 illustrates the presence of carpal tunnel symptoms and the percentages for each. The most commonly reported symptoms of carpal tunnel syndrome were tingling (58%) and numbness (47%) while the least reported symptoms were burning sensation (8%) and edema (12%). Nocturnal pain was reported by 37% while weak grip was reported by 29% of respondents. Other symptoms included sensory changes (20%) and increased muscle tension (24%).

Severity of symptoms was characterized as either mild, moderate or severe. Ninety percent (n=53) of those reporting symptoms reported mild symptoms while only 10% (n=6) reported moderate severity, and none reported symptoms as severe (Table 4). Additional comments from respondents included ulnar nerve numbness and tingling at both wrists and elbows with associated weakness of grip. When asked when the majority of symptoms occurred, 1 reported constant, 4 reported the occurrence as inconsistent, 5 reported after heavy caseload, 24 reported...
Table 3
Symptoms of Carpal Tunnel Syndrome Reported (n=59)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Responses</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>tingling</td>
<td>34</td>
<td>58%</td>
</tr>
<tr>
<td>numbness</td>
<td>28</td>
<td>47%</td>
</tr>
<tr>
<td>nocturnal pain</td>
<td>22</td>
<td>37%</td>
</tr>
<tr>
<td>weak grip</td>
<td>17</td>
<td>29%</td>
</tr>
<tr>
<td>increased muscle tension</td>
<td>14</td>
<td>24%</td>
</tr>
<tr>
<td>sensory changes</td>
<td>12</td>
<td>20%</td>
</tr>
<tr>
<td>edema</td>
<td>7</td>
<td>12%</td>
</tr>
<tr>
<td>burning sensation</td>
<td>5</td>
<td>8%</td>
</tr>
</tbody>
</table>

Table 4
Severity of Symptoms (n=59)

<table>
<thead>
<tr>
<th>Symptomology</th>
<th>Responses</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>mild</td>
<td>53</td>
<td>90%</td>
</tr>
<tr>
<td>moderate</td>
<td>6</td>
<td>10%</td>
</tr>
<tr>
<td>severe</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

after tool/modality use, and finally, 25 reported symptoms occurring at night. Warning signs of carpal tunnel syndrome included fluttering of fingers (n=3), shaking of hands (n=13), homemade adaptations of tools (n=6), protective holding of wrist or hand (n=21) and deep rubbing of the forearm, wrist and/or hand (n=21). Other signs reported were fatigue in hands, decreased writing skills, and tingling at wrists and hands.
When asked about medical treatment sought for carpal tunnel symptoms, 1 reported acupuncture, 4 reported a physician's care, 4 reported surgery, 9 reported medication, 23 reported splinting, and 42 reported self-treatment. Lost days from work were reported by 4 hand therapists between two to five weeks with an additional four weeks of light duty.

In order to determine what proportion of hand therapists reported carpal tunnel symptoms as compared to industrial workers, a z score was calculated. Statistical significance was determined with $z=5.82$ and alpha=1.645, therefore hypothesis 1 was accepted and the null rejected. An examination of the incidence of carpal tunnel symptoms and the presence of contributing factors identified as stress, high physical demands, average daily caseload, number of tool/modality use, splinting methods and frequency of tool/modality use was conducted using chi square analysis. Table 5 shows the correlations between stress in one's job and the reporting of carpal tunnel symptoms. Forty-nine percent ($n=29$) of the respondents who reported the presence of carpal tunnel symptoms also reported stress in one's job while 51% ($n=30$) did not. Of 167 respondents, 35% ($n=59$) reported symptoms with and without stress. Chi square analysis revealed chi square=19.911. The data indicated there was a relationship between subjects reporting carpal tunnel symptoms and the presence of stress in one's job with a significant probability at .001.
Table 5
Stress Reported in One's Job

<table>
<thead>
<tr>
<th>Symptomology</th>
<th>yes/stress</th>
<th>no/stress</th>
<th>N=total</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>29</td>
<td>30</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>49%</td>
<td>51%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>153.7</td>
<td>153.7</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>18</td>
<td>90</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>17%</td>
<td>83%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>153.7</td>
<td>153.7</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>129</td>
<td>167</td>
</tr>
</tbody>
</table>

$X^2=19.911, \ p<.001$

Table 6 demonstrated a positive correlation between high physical demands and the reporting of carpal tunnel symptoms. Of 167 respondents, a total of 59 reported carpal tunnel symptoms with 46% high physical demands and the reporting of carpal tunnel symptoms. Of 167 respondents, a total of 59 reported carpal tunnel symptoms with 46% ($n=27$) having indicated high physical demands on the job while 54% ($n=32$) of them did not. Statistical analysis revealed chi square=23.826 with a significant probability at .001.

Table 7 examined the number of tools/modalities used daily and the presence of carpal tunnel symptoms. Respondents reported daily use consisting of 0-5, 6-10, and ≥11 tools/modalities. Seventy-five percent ($n=44$) of those with symptoms reported 6-10 tools/modalities used daily.
Table 6

High Physical Demands In Job

<table>
<thead>
<tr>
<th>Symptomology</th>
<th>yes/high physical demands</th>
<th>no/high physical demands</th>
<th>N=Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>27</td>
<td>32</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>46%</td>
<td>54%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>165.6</td>
<td>165.6</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>13</td>
<td>95</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>12%</td>
<td>88%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>165.6</td>
<td>165.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>127</td>
<td>167</td>
</tr>
</tbody>
</table>

$X^2=23.826, p<.001$

Table 7

# Of Tool/Modality Use Daily

<table>
<thead>
<tr>
<th>Symptomology</th>
<th>0-5</th>
<th>6-10-</th>
<th>&gt;11</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>8</td>
<td>44</td>
<td>7</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>14%</td>
<td>75%</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>68</td>
<td>52.7</td>
<td>.98</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>38</td>
<td>60</td>
<td>10</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>35%</td>
<td>55%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>68</td>
<td>52.7</td>
<td>.98</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>104</td>
<td>17</td>
<td>167</td>
</tr>
</tbody>
</table>
Only 12% \((n=7)\) reported ≥11 tools/modalities used daily and 14% \((n=8)\) reported between 0-5 tools/modalities used daily. Statistical analysis revealed chi square=8.949 with a significant probability at .05.

Next, average daily caseload was reported ranging from 1-8, 9-12, 13-16 and >16 clients and the possible correlation between caseload and symptomatology was examined (Table 8). Statistical analysis using chi square revealed chi square=8.559 which was significant at .05. Twenty-seven percent \((n=16)\) of respondents who reported carpal tunnel symptoms also reported an average daily caseload >16 clients while only 9% \((n=10)\) of those who did not report symptoms shared the same daily caseload.

In analyzing primary splinting method as a possible contributing factor to the reporting of carpal tunnel symptoms (Table 9), 75% \((n=44)\) of those reporting symptoms indicated custom splinting as a primary method while 25% \((n=15)\) reported a combination of custom, prefabricated and preformed as the primary method of splinting. Overall, 36% \((n=59)\) of respondents reported symptoms of carpal tunnel syndrome while 64% \((n=104)\) did not. Statistical analysis revealed chi square = 0.039 which was not significant at .05.

Finally, a possible correlation between the frequency of tool/modality use and the reporting of symptoms was examined (Table 10). Of 145 respondents who responded to this item on the questionnaire (21 did not), 35% \((n=51)\) reported carpal tunnel symptoms while 65% \((n=94)\) did not.
Eighty-eight percent \((n=45)\) of those reporting symptoms reported frequency of tool and modality use as daily while 12\% indicated frequency as \(\leq 50\%\) of the time. Chi square analysis revealed chi square=7.829 with a significant probability at .01. Eighty-eight percent \((n=46)\) of those reporting symptoms reported frequency of tool and modality use as daily while 12\% indicated frequency as \(\leq 50\%\) of the time. Chi square analysis revealed chi square=7.829 with a significant probability at .01.

Data analysis using chi square for independence was conducted to determine if those variables that contribute to the incidence of carpal tunnel syndrome were statistically significant at .05. Findings indicated that the contributing factors of stress, high physical demands, daily number of tool/modality use, average daily caseload, and frequency of tool/modality use were dependent of the symptoms of carpal tunnel syndrome at .05 level of significance. Therefore, hypothesis 2 was accepted and the null rejected. However, primary splinting method was not found dependent of the symptoms of carpal tunnel syndrome at .05 level of significance and therefore could not be identified as a contributing factor.
Table 8

Average Daily Caseload

<table>
<thead>
<tr>
<th>Symptomology</th>
<th>1-8</th>
<th>9-12</th>
<th>13-16</th>
<th>&gt;16</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>13</td>
<td>16</td>
<td>14</td>
<td>16</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>22%</td>
<td>27%</td>
<td>24%</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.5</td>
<td>22.46</td>
<td>.577</td>
<td>38.56</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>26</td>
<td>43</td>
<td>29</td>
<td>10</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>24%</td>
<td>40%</td>
<td>27%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.5</td>
<td>22.46</td>
<td>.577</td>
<td>38.56</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>59</td>
<td>43</td>
<td>26</td>
<td>167</td>
</tr>
</tbody>
</table>

\[X^2=8.559, \ p<.05\]

Table 9

Primary Splinting Method

<table>
<thead>
<tr>
<th>Symptomology</th>
<th>Custom</th>
<th>*Combination</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>44</td>
<td>15</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>75%</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.27</td>
<td>.27</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>79</td>
<td>25</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>76%</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.27</td>
<td>.27</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>123</td>
<td>40</td>
<td>163</td>
</tr>
</tbody>
</table>

\[X^2=0.039, \ p>.05\]

*Combination=prefabricated, performed, custom
Table 10

Frequency of Tool/Modality Use

<table>
<thead>
<tr>
<th>Symptomology</th>
<th>Daily</th>
<th>≤ 50%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>45</td>
<td>6</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>88%</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>49.14</td>
<td>49.14</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>63</td>
<td>31</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>67%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>49.14</td>
<td>49.14</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>37</td>
<td>145</td>
</tr>
</tbody>
</table>

$X^2 = 7.829, \ p < .01$
CHAPTER V

DISCUSSION

This study aimed to identify the proportion of hand therapists reporting CTS symptoms as compared to that found among industrial workers (18%) as described in the literature. The hypothesis that the proportion of hand therapists with CTS symptoms (35%) was equal to or greater than that found among industrial workers was supported. In addition, the presence of contributing factors to the development of carpal tunnel symptoms as discussed in the literature were identified and the relationship between the presence of CTS symptoms and stress, high physical demands, number of tool/modality use, and frequency of tool/modality use on the job was proven statistically significant with the exception of splinting method. This finding probably may have been confounded by the variety of splinting methods reported by subjects.

Biomechanical analysis revealed custom splinting involving wrist flexion, extension and deviation with increased muscle tension in the forearm, wrist and hand that fulfilled the criteria for conditions contributory to developing CTS as described in the literature, especially when repeated several times a day, several days a week. However, the
reality may be that more therapists are choosing prefabricated splinting methods over custom ones as a preventative measure which would explain the lack of statistical significance in identifying a relationship between splinting method as a contributing factor to the reporting of carpal tunnel symptoms. Further investigation is needed to explore this issue and determine its relevance to the onset of cumulative trauma disorder on the job and whether splinting method has been altered as a preventative measure.

Stress, high physical demands, the number of tools/modalities used daily in one's job, average daily caseload, and frequency of tool/modality use were found to be highly significant. These findings support much of the research presented in the literature on the physiological effects of stress, high physical demands and repetitive wrist and hand movements that result from frequent tool use involving wrist flexion, extension, deviation and grasp and the onset of carpal tunnel symptoms.

In Table 5, the number of those reporting job stress and carpal tunnel symptoms \((n=29)\) was significantly greater than those reporting job stress and no symptoms \((n=18)\). Of 108 respondents reporting no carpal tunnel symptoms, 83% reported no job-related stress. As presented in the literature, the differences in the reporting of carpal tunnel symptoms and job stress support the relationship of stress as a contributing factor to the development of carpal tunnel syndrome.
In Table 6, a total of 40 respondents (24%) answered positively to high physical demands on the job of which 67.5% of them reported carpal tunnel symptoms. Meanwhile, 88% of those responding "no" to symptomology also responded "no" to high physical demands on the job. The significant differences in the reporting of CTS symptoms supports the presence of contributing factors; in this case, high physical demands.

In Table 7, of those reporting symptomology (n=59), 75% reported an average use of 6-10 tools/modalities daily while only 14% reported an average of 0-5 tools/modalities and 12% reported an average of ≥11 tools/modalities used daily. Of those reporting no symptomology (n=108), 35% reported an average of 0-5 tools/modalities used daily while 5.5% reported 6-10 tools/modalities and 9% reported an average of ≥11 tools/modalities used daily. The significance of these findings was that the majority of those experiencing carpal tunnel symptoms used 6-10 tools/modalities which constitutes repetitive wrist and hand movements and repetitive grasp combined with high physical demands, all of which contribute to the development of carpal tunnel symptoms. Of a total of 176 respondents, 35% reported symptomology which is significantly more than 18% as described among industrial workers in the literature.

Table 8 showed that the observed outcomes for symptomology increased as the average daily caseload increased which supports repetition as a key factor in developing cumulative trauma such as carpal tunnel
syndrome. Of those reporting symptomology (n=59), 27% reported an average daily caseload of >16 as compared to only 9% of those not reporting symptomology. Differences in reporting between part time and full time hand therapists were not examined statistically since work status was not clearly defined by the researcher and many part time therapists indicated working between 30 and 34 hours per week which may have been considered full time by others.

In Table 10, which examined symptomology and frequency of tool/modality use, 88% of those reporting carpal tunnel symptoms indicated "daily" tool/modality use while 12% reported a frequency of less than or equal to 50% of the time. Of those without symptoms, 33% reported frequency of tool/modality use as less than or equal to 50% of the time. Here again, the pattern of reporting symptoms in the presence of contributing factors supported hypothesis 2 which stated that the presence of carpal tunnel symptoms was dependent on the existence of contributing factors.

The presence of other overuse symptoms, i.e., De Quervain's, cubital funnel syndrome and trigger finger, were reported by respondents to this survey subsequent to "hands on" treatment interventions. Poor body mechanics and posture, increased muscle tension and high repetition may account for other cumulative trauma disorders as well. Upon examination of medical treatment received for carpal tunnel symptoms, 42 respondents
indicated self-treatment while 23 reported splinting and one utilized acupuncture. Only 4 reported a physician's care while 9 took medication for carpal tunnel symptoms. The reality of therapists self-treating causes concern as the presence of occupational hazards go unnoticed and unreported through necessary channels. Such hazards need to be addressed and corrective action taken through proper channels. Ultimately, job modifications and education regarding prevention of cumulative trauma disorders need implementation. Further investigation of other work-related overuse syndromes not addressed in this study would be warranted as well.

Limitations of this study included the acceptance of a broad spectrum of one or more symptoms for consideration of positive carpal tunnel syndrome. However, the intent of this study was not to "diagnose" carpal tunnel syndrome among respondents but to identify symptoms. Diagnosis can only be made by a physician. Another limitation of this study was that the survey section for medical histories did not clearly indicate diagnosis made by a physician but could have been self-diagnosed since it was posed to a group of health professionals knowledgeable about various medical conditions as compared to the average public. The reality of "hands on" methods of treatment being assigned to aides who were not included in this study but who may be equally suffering or at risk, needs exploration through further study.
Many respondents noted a strong interest in the results of this study and were supportive of the research effort into this mode of treatment intervention. It clearly was an area of concern for many.

Conclusion

As demonstrated by the findings of this study, the profession of hand therapy poses risk for developing carpal tunnel syndrome when intervention favors a "hands on" approach and practice involves the presence of stress, high physical demands, high caseloads, and high frequency of tool/modality use on a daily basis. this may be true for other occupational and physical therapists practicing in physical disabilities who perform manual therapies as well. The importance of providing education in terms of proper body mechanics, ergonomic tool use and prevention is essential if a decrease in the incidence of carpal tunnel syndrome and other cumulative trauma disorders is desired. Future research could investigate further the relationship of specific tool/modality uses and "hands on" techniques of treatment that might pose greater risk than others. The issue of professionalism and self-treatment is another area that warrants consideration while examining motivational aspects. Are therapists extending themselves beyond the boundaries of occupational safety for the sake of their clients? These are just a few suggestions for continued exploration of this topic.
Appendix A

Sample Letter
Dear Therapist,

I am a graduate student in the department of Occupational Therapy at Western Michigan University currently conducting a study about carpal tunnel syndrome. You have been specially chosen based upon membership to the American Society of Hand Therapists to participate in an important new study dealing with possible risk factors among hand therapists for developing carpal tunnel syndrome. Through your participation, an important impact on future education and training of hand therapists could be made in terms of prevention of work-related injury.

Participants names will not be recorded for any reason, so anonymity will be assured. Enclosed is a questionnaire to be completed and returned no later than February 26, 1990.

Your participation is greatly appreciated.

Sincerely,

Suzanne Makielski
CTS: Risk Factors Among Hand Therapists

I.D. Number: __________________ Sex: M __ F

Status: □ part-time □ full-time □ OT □ PT Age: ________

Average caseload per day: □ 5-8 □ 9-12 □ 12-16 □ above

Splinting: □ performed by therapist □ performed by assistant

Splinting method: □ custom-made □ prefabricated

Frequency of splints: □ # per week □ # per month

Please list hand tools used in your job:

Please list the types of modalities used:

How often do you use them? (please describe)

Personal Medical History: please check

□ rheumatoid arthritis
□ upper extremity fractures
□ tumors
□ tenosynovitis
□ pregnancy (presently)

□ polyneuropathy
□ diabetes
□ other systemic disease
□ oral contraception
□ hysterectomy

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Symptoms of CTS: please check those that you presently exhibit

- numbness
- tingling
- nocturnal pain
- sensory changes
- burning sensation
- weak grip
- edema
- increased muscle tension

Severity of Symptoms:  □mild □moderate □severe

When do the majority of symptoms occur?

Warning signs: please check those you exhibit

□ fluttering of fingers □ protective holding of wrist or hand
□ shaking of hands □ deep rubbing of the forearm, wrist
and/or hand □ homemade adaptation of tools

Other CTS factors existing in your life (job?):

□ stress □ high physical demands at work

Medical treatment you have received for CTS:

□ physician □ splinting
□ medication □ self-treated
□ surgery

Lost days from work for CTS:_________________________________________________
Additional comments or observations:
Appendix C

Approval Letter From the Human Subjects Institutional Review Board


