INDUSTRIAL WORK INJURIES: CARPAL TUNNEL SYNDROME

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OUTLINE

Key Indexing Terms: Industrial work injuries; carpal tunnel syndrome.

I CTS OVERVIEW

During the working years (ages 18 to 64) more people are disabled from musculoskeletal problems than from any other category of disorder. (1, 2). The majority of these musculoskeletal injuries are not from the result of accidents caused by macro-traumatic events but rather, they develop gradually as the result of repeated microtrauma. Over 200 years ago, an Italian physician Bernardino Ramazinni identified two types of workplace hazards, one deriving from "harmful character of materials — handled" and the other from "certain violent and irregular motions and unnatural postures of the body, by reason of which the natural structure of the vital machine is so impaired the serious diseases gradually develope therefrom" (3). The '"certain violent and irregular motions"' may refer to those repetitive activities which lead to microtrauma, repetitive trauma, cumulative trauma. Such disorders commonly involve the upper extremity rather than the lower extremity and can gradually progress eventually affecting the entire upper quarter. Because of the slow and gradual onset, the condition is often ignored until the symptoms become chronic and sometimes permanent Representative syndromes are bricklayers shoulder, carpenter elbow, tennis elbow, stitcher's wrist, gamekeepers thumb, telegraphistś cramp, and cotton-twister's hand.

Carpal tunnel syndrome (CTS) is one type of repetitive injury. A US Bureau of Labor Statistics survey found CTS to be the leading cause of work-related disability among American workers, with nearly 90,000 cases resulting in lost work time in 1992 alone (4). A plausible explanation is the increased pace of work tasks (5): workers often report speed of the assembly line as a factor in overuse syndromes or cumulative trauma disorders. A second factor may be the graying of the work force as the population ages and people work later in life. (6). People over 50 years of age have a greater risk at failing conservative medical treatment (7). Other characteristics of the CTS population include a gender difference where 3 times as many women report injury as men. The peak incidence for women is between 45 to 54 years of age (8).

CTS is characterized as a chronic, painful condition primarily affecting the radial half of the wrist and hand.

The basic etiology underlining the syndrome is compression of the median nerve, which runs through the carpal tunnel of the wrist and into the hand. The individual suffering from CTS will typically present with paresthesia or numbness affecting to varying degrees, the thumb through radial half of digit 4. Sensory loss to the thenar aspect of the hand is usually spared due to the palmar branch of the median nerve exiting 3 cm proximal to the transverse carpal ligament. Sensory symptoms are usually noted first but, early examination often yields negative findings. Symptoms usually begin in the distal aspect of the third digit (9,10) but can also extend proximally to the elbow and at times further to the cervical spine.

II ETIOLOGY

One mechanism of carpal tunnel syndrome is tendinitis of the flexor tendons and their associated sheaths in the antebrachium. The expansion caused by inflammation of the flexor tendons in the confined space of the carpal tunnel results in neurological compression of the median nerve. Another mechanism is the compression of the median nerve by direct contact with the flexor tendons during repeated finger and wrist flexion movements.

Compression of the median nerve can occur in series along its course through the brachium and antebrachium or at a single site such as the carpal tunnel. Another common site of compression is at the pronator teres muscle in the proximal flexor antebrachium. When two or more sites of compression exist, the term double crush or multiple crush syndrome is applicable (11). Because of the confined space of the carpal tunnel, the neurological compression can be caused or exacerbated by repetitive hand or arm movements associated with certain jobs. Occupations that demand static or prolonged awkward positions, high levels of force, a high frequency of repetition, and little to no recovery time can result in carpal tunnel syndrome and other CTD's.

The common denominator behind CTD's including carpal tunnel syndrome, is the element of overuse superimposed on the progressive changes that accompany the normal aging process of the body. (12). A convenient formula for defining CTD's is:

FORCE + REPETITION + AWKWARD POSTURE + NO REST = CTD

CTD's are more prevalent among the working class than among the general population, which suggests occupation is a risk factor. Atcheson states that carpal tunnel syndrome patients often "have a high prevalence of concurrent medical conditions capable of causing CTS without respect to any particular occupation." (4). Atcheson and colleagues conducted physical examinations and medical-record reviews of 297 patients diagnosed with CTS or similar wrist, arm, or hand pain. They found that "109 separate diseases or illnesses capable of causing arm pain, CTS or (nerve inflammation) were identified in 98 patients (33%)." These conditions included obesity, hypothyroidism, diabetes, rheumatoid arthritis, and lupus. Overall, 40% of patients defined as having CTS "were found to have a metabolic, inflammatory, or degenerative condition that might have caused the symptoms." The authors point out that "only 35 patients (11.8%) knew that they had any of these conditions." This high level of missed diagnoses may lie in the fact that the physicians who treated these patients, "seldom sought nonoccupational explanations for suspected CTS," the authors say. Obviously, proper management of CTS in these cases relies on an accurate diagnosis and consideration for co-morbid factors.

Recreational exposure must also be considered as an origin or risk factor (13). Sports such as cycling, rowing, and weight lifting are examples of sports that can provoke or exacerbate the syndrome.

MANAGEMENT

ERGONOMIC

Similar to the management of other musculoskeletal disorders, the treatment outcome of patients with carpal tunnel syndrome may range from poor to good, depending on the various risk factors associated with each individual case. Therefore, it is necessary to assess the patient completely so that all risk factors can be identified at the initiation of treatment. Atcheson has recommended in addition to clinical examination, a laboratory examination be performed to include an arthritic profile, thyroid profile, and glucose whenever these conditions are suspect. I also routinely include a sedimentation rate and a Lyme's Disease test. Once these conditions have been ruled out, ergonomic issues should be addressed.

There have been times in my experience where the treatment of carpal tunnel syndrome was totally ineffective regardless of the methods utilize, until the ergonomic issues were directly evaluated and managed. Using the SOAP breakdown of reporting in a clinical setting as an outline, a proper assessment includes the following:

SUBJECTIVE

A detailed history taken from the patient regarding their work demands (a Job Demands Questionnaire can be most helpful)

Specific questioning with respect to upper quarter, especially the hand and wrist positions that are employed during the injured worker's occupation

Request permission to videotape the injured worker's workstation and analyze the videotape of the patient performing their tasks for the following:

Classification of occupational frequency by timing one work cycle (high frequency equals < 30 seconds; low frequency equals > 30 seconds to complete one work cycle)

Identify faulty hand and wrist positions (positions at extreme end points of range of motion)

Observe for forearm resting on sharp edges such as a counter or tabletop

Observe for firm pinching and/or gripping, especially in awkward positions

Utilize the time-methods analysis approach for job site evaluation

Identify cold temperature risk factors (the environment, tools, etc.)

Note the use of vibratory tools, and/or whole body vibration sources

Note the handle direction of the tools — do they ergonomically ìmake sense?î

NOTE: Utilizing a survey that workers can complete can help identify those who are currently suffering from a CTD. An example of a survey and pain drawing can be found in the notes (P43 of Vern-Putz Anderson ref(12)).

Obtain from the patient, a hand pain drawing and outcome assessment forms including the Carpal Tunnel Syndrome Questionnaire, Upper Extremity Questionnaire, Neck Disability Index, and a quality of life measure such as the SF-36

Utilize a risk assessment tool to identify patients who are likely to have a prolonged recovery such as a Vermont Disability Prediction Questionnaire (14), and / or the Severity Index (15)

Utilize a Job Satisfaction Questionnaire, especially when there is difficulty returning a patient to work (16)

Note: the use of patient driven outcomes management tools such as those mentioned in the last three bullets are critical when making treatment plan decisions and to substantiate medical necessity for care. These are also useful for patient education and report of findings as well as identifying end points in care, which can help the provider make prompt clinical decisions with respect to case management. Please contact the author for further information as to where to obtain these various tools.

OBJECTIVE

Quantify objective testing procedures by, for example, timing (in seconds) the onset of paresthesia when performing orthopedic testing (eg., ìPhalen's test + at 3 seconds, D2-4;î ìcarpal tunnel compression = D2,3 paresthesia at 4 seconds,î etc.)

Use valid/reliable provocative tests such as Phalen's 70% sensitive, 80% specific, Tinel's 61% sensitive, 94% specific (17,18), carpal compression test (CCT) (87% sensitive, 95% specific) (19)

Carefully assess grip strength by the use of a well calibrated dynamometer and averaging three separate strength assessments that are within 20 percent of each other

Utilize Semmes-Weinstein monofilaments for obtaining the most accurate low tech method of sensory perception testing of the hand (91% sensitive, 86% specific) (17,18)

Always assess the peripheral joints proximal and distal to the injured region. In CTS, this includes the cervical spine, shoulder, elbow, wrist and hand

Pay particular attention to the course of the median nerve, especially as it transcends through the pronator teres muscle, often referred to as the pronator tunnel

Goniometric assessment of wrist palmar flexion and dorsiflexion

Circumferential mensuration of the wrist, proximal forearm, and brachium

Treatment outcome of CTS is also dependent, at least in part, on the passive approaches utilized. The common chiropractic management approach to CTS often includes wrist splinting, addressing ergonomic issues, bony and soft tissue manipulation usually of the cervical and thoracic spine and upper extremity including the hand, wrist, forearm, elbow and shoulder. An important issue to consider when passive care management approaches of CTS are utilized, is the avoidance of iatrogenic aggravation of the condition. Failure to identify nerve damage (axonal degeneration) may represent such an example. Dawson describes clinical findings that relate to a poor prognosis regardless of the therapeutic approach, which include (9):

thenar wasting
skin atrophy
dexterity loss

Also, the length of time the median nerve is compressed is less important than the amount of compression as irreversible nerve damage can occur in a very short time duration in an acute case of CTS such as with bleeding into the CT following a Colles' wrist fracture. Dawson describes cases of chronic long-standing CTS that remain EMG/NCV negative when tested years after symptom onset in contrast to the case of acute CTS secondary to fracture where electrodiagnostic findings are found early on (9).

WORK STATION EVALUATION
WORK-METHODS ANALYSIS

In this method, each movement of a job being analyzed is broken down into a set of tasks. Each task is defined as an element (20). Elements are fundamental acts or movements such as reaching, grasping, moving, positioning, etc. that are utilized when working. This system relies on describing each manual movement using elements that are specifically defined in the job-site worksheet found in the notes.

TASK ELEMENTS	DESCRIPTION
1. SEARCH	LOOKING (EYES OR HAND)
2. SELECT	LOCATING ONE OBJECT THAT IS MIXED IN WITH OTHERS
3. GRASP	TOUCHING OR GRIPPING AN OBJECT WITH THE HAND
4. REACH	MOVING OF THE HAND TO SOME OBJECT OR LOCATION
5. MOVE	MOVEMENT OF SOME OBJECT FROM ONE LOCATION TO ANOTHER
6. HOLD	EXERTING FORCE TO HOLD AN OBJECT ON A FIXED LOCATION
7. POSITION	MOVING AN OBJECT IN A DESIRED ORIENTATION
8. INSPECT	EXAMINING AN OBJECT BY SIGHT, SOUND, TOUCH, (I.E., SPECIAL SENSES)
9. ASSEMBLE	JOINING TOGETHER TWO OR MORE OBJECTS
10. DISASSEMBLE	SEPARATING TWO OR MORE OBJECTS
11. USE	MANIPULATING A TOOL OR DEVICE WITH THE HAND
12. UNAVOIDABLE DELAY	INTERRUPTING WORK ACTIVITY (The factor is beyond the worker's control)
13. AVOIDABLE DELAY	INTERRUPTING WORK ACTIVITY (The factor is under the worker's control)
14. PLAN	PERFORMING MENTAL PROCESS THAT PRECEDES MOVEMENT
15. REST TO OVERCOME FATIGUE	Interrupting work activity TO REST (To overcome the effects of repetitive work)

This approach is called the MTM or Methods Time Measurement system. The use of videotapes of the worker played back in slow motion greatly facilitates the evaluation process of identifying each element. The time required to complete one work cycle (the cycle time) is accomplished by using a stopwatch while observing the worker on the job or playing the video tape at normal speed. This allows for classification of the job into high or low frequency. High frequency is defined as one cycle completed in less than 30 seconds or, if more than 50% of the cycle time is involved performing the same kind of task (referred to as Fundamental Cycle). Low frequency is defined as greater than 30 seconds to complete one cycle, or if less than 50% of the cycle time is involved performing the same kind of fundamental cycle. It has been reported that workers in high frequency repetitive work positions have a 31% greater risk for tendinitis compared to workers in low frequency jobs (12).

Once the frequency of the job site has been calculated, the next item to attend to is assessing each element for biomechanical faulty positions or risk factors. An attribute or exposure that increases the probability of the disease or disorder is considered a risk factor (12). Risk factors for CTD's include (but are not limited to) repetitive and sustained exertions, awkward postures, high mechanical forces, vibration, cold temperature, and infrequent rest periods. Using an example of a bottle packing job task, the elements and associated biomechanical risks that may exist include:

Reach — elbow above mid-torso height

Grasp — elbow above mid-torso height pinching the bottles

Position — pronation of the forearm with a palmar flexed wrist; sharp edge on the container rubs on base of palm.

When breaking down complex motion patterns into manageable units or elements, identifying the potential biomechanical risk factors becomes easier. Only then can the risk factors be effectively modified. This is best completed after viewing the videotape several times at regular speed as well as during slow motion. This step can also facilitate a 'round table discussion' approach where the patient, supervisor, engineer, HRO rep, RN, etc., meet with you and the video is played and rewound several times at different speeds while each person contributes to a master list of remedies. This author has been involved in a similar arrangement where 5 work stations at a battery manufacturing plant were analyzed. A safety committee made up of fellow workers, an engineer, the HRO rep, the supervisor, the foreman, several health care providers, and the patient then reviewed the videotape. Dialogue with the HRO representative one year later revealed over 70% less costs associated with work injuries in the 5 stations that year following the evaluation compared to the previous year.

In summary, the MTM method includes:

Assess the frequency of the job task and classify it as low or high frequency

Assess the each element for biomechanical risk factors

For each risk factor, determine a remedy or solution of the problem

Meet with the patient and employer-based personnel to review the tape and discuss potential remedies

The first 3 of the 4 items listed above make up the MTM approach. The last item, in my experience, has been the most successful way to obtain a favorable outcome of the ergonomic evaluation process. Otherwise, only reporting the information leaves too many unanswered questions regarding possible remedies, which is the most important factor affecting the outcome of the work.

CHECKLISTS

As an alternative to the work-methods analysis, a checklist itemizing undesirable worksite conditions or worker activities can be used. There are many types of checklists but most important is to customize the checklist to the specific job site being evaluated. A walk through survey of the job site should be performed to become oriented to the specific attributes of the job site and to insure that the checklist can identify the risk factors adequately. Appropriate modifications of the checklist should be made if necessary. In addition, for each biomechanical risk factor evaluated, the amount of effort or force relative to holding, assembling and pinching as well as posture related problems associated with reaching, inspecting and assembling should be included. Most checklists include items that cover the following 4 problematic work conditions:

Crowding or cramping of the worker — the layout should allow for proper bending, movement, and reaching

Twisting or turning — Tools and other material placement should be easily accessed from the worksite so that twisting/turning can be avoided.

Repeated reaching motions — avoidance of leaning or twisting to reach for objects or controls

Misalignment of body parts — avoidance of one shoulder to be higher than the other and spinal bending to one side excessively

An example of a 'yes — no' checklist that can serve as a foundation to modify from can be found in the notes. A scoring method of the checklist can be easily obtained where the total number of 'yes' items are divided by the total number items times 100 to yield a score based on a 100% scale regarding the risk for developing CTDs.

NOTE: Work station questionnaires such as Michigan's checklist for upper extremity cumulative trauma disorders can be quite helpful (see accompanying notes for a copy — P51 of Vern-Putz Anderson ref. Note, they reference Lifshitz Y, Armstrong T. A design checklist for control and prediction of CTDs in hand intensive manual jobs. Proceedings of the 30th Annual Meeting of Human Factors Society, 1986; pp837-841.). (12)

ASSESSING BIOMECHANICAL RISK FACTORS

Possible biomechanical risk factors include:

- Stressful postures
- Excessive or repeated force
- High repetition or frequency

Stressful Postures

Postures that force any joint beyond its normal ROM can disrupt fibers of the joint capsule or neighboring muscle components resulting in injury.

SHOULDER:

Reach /work above shoulder level — associated with shoulder tendinitis and/or Thoracic outlet syndrome.

Repetitive reaching behind such as optical price scanners (check out clerks)

ELBOW

Internal/external rotation of the forearm, especially with a bent wrist and elbow — epicondylitis (medial &/or lateral)

An extended elbow and a flexed wrist place mechanical disadvantage on the forearm flexors — and forceful lifting or screwdriver work can overload the muscles resulting in 1st, 2nd, or 3rd degree strain (1st = mild without tissue disruption while 3rd is a complete tear).

HAND & WRIST

Wrist & hand postures greatly influence strength:

Frontal plane — ulnar deviation at 45° = 25% less strength vs. at neutral;

radial deviation of 25(= 20% less;

Sagittal plane — extension 45° = 25% less; flexion of 45° = 40% less and 65° = 55% less strength vs. at neutral

Power vs. Precision grasp (power grip is 5x stronger)

Pinch — 3 types (in descending order of strength): Lateral (or, Key) pinch — the thumb pinches against the radial side of D2's PIP; Pulp - the palmar surfaces of the distal phalanx of D2 and the thumb press together; Tip — the tips of thumb and D2 pinch together (best precision/weakest pinch)

Grip — Power grasp include medial grasp (eg. gripping a ball); Cylindrical or spherical grip (eg. gripping an oar and door knob, respectively)

The best way to measure risk factors is by employing the Work-Methods analysis approach, since each job is so different. A checklist may work but in my experience, it is harder to determine the remedies for the faulty workstation or worker.

FACTORS AFFECTING FORCE

Handle or object properties that affect force requirements include: Slippery surfaces, sizes that are too large or small for the hand, cold temperatures, dull edges of knives, scissors, etc., wearing gloves, heavy tools, sweaty/wet hands, greasy oily surfaces

Posture — affects force requirements. Examples include: lifting a box by pressing in from the sides (finger pressing = precision) vs. using finger cut-outs hooking the fingers through the holes or by using attached handles (palm pinch = power grip).

Measuring force is difficult as workers vary in strength, based on body size, gender, etc. Needle EMG can measure amplitude of strength but is restricted to the lab. Although awkward, surface EMG can be used at the worksite but is not very practicable. It is more practical to look for individual traits, such as compensatory movements as mentioned above.

EVALUATING FREQUENCY OF MOVEMENTS

Cycle time measurement examples:

Bottle packing requires 36 seconds to pack a case of 24 bottles, the fundamental cycle is therefore 36/24 or 1.5 seconds.

Packing cookies: if it takes 5 seconds to pack a plastic tray with 10 cookies, the cycle time is 5/10 or 0.5 seconds.

Sanding parts takes 45 seconds to finish each part, but 30 of the 45 seconds are needed to move the sander 5 times while the remaining 15 seconds involve handling and positioning the part to and from a box. The fundamental cycle is therefore 30/5 or 6 seconds.

One can see from these examples, that the shorter the fundamental cycle time, the less rest or recovery time is available. This will be further elaborated in the next section.

EVALUATING WORK STATIONS AND WORKER POSTURE

A job analysis must include a study of the work environment. This includes relevant work fixtures, such as the work table, stools or chairs, and any supply and output containers. Tools are specifically not included in this part of the evaluation and should be analyzed separately. Static work often results in discomfort and fatigue due to static contraction of muscles in fixed or awkward positions for lengthy time periods. Work conditions that are recognized as requiring considerable static hand-and-arm effort are defined as follows:

High effort lasting 10 seconds or more, e.g., holding an object of 4 kg

Moderate effort lasting 1 minute or more, e.g., holding an object of 2 kg

Slight effort lasting 4 minutes or more (about 1/3 of maximum force)

Overhead work reduces blood flow to the larger muscles in the shoulder girdle, which results in the familiar sensation of muscle burning — an indicator or warning sign to rest. Muscles subjected to static work require more than 12 times longer than the original contraction-duration for complete recovery from fatigue (12). Also, muscles of the upper extremity cannot maintain a contraction level in excess of 20% of their maximum voluntary contraction for more than a few seconds without significant fatigue. The actual duration of exertion is dependent on the load and the individual muscle group. The amount of time required to maintain a contraction, or holding time, drops logarithmically with increases in force. Therefore, muscles that are moved repetitively are often more resistant to injury than statically held muscles, since they fatigue slower. Therefore, when rehabilitation is being applied to the injured worker, endurance training is preferred over strength training. Factors such as the work space reach limits, the height of the work surface, sitting vs. standing allowances, and tool design in relationship to body/arm/hand position also affect worker performance and fatigue rates. In general, tasks that require more force or power are better accomplished from a standing position and allowances for either sitting or standing offer the worker the ability to change position as often as needed, reducing static loading forces.

EVALUATING TOOLS, HANDLES AND CONTROLS

The handle of a tool, a container or a machine control should be designed to fit capabilities of the human hand and arm. Often, finding the correct size, shape, or weight of the tool is a matter of trial and error. Undesirable characteristics of poorly designed tools may include an awkward grip, a handle that forces the wrist to bend awkwardly, a trigger that requires heavy pressure, a poorly balanced tool, and low frequency vibration. Tools that have sharp edges where frequent and sustained contact is required, such as a pliers can create injury. This is due to the compression forces that are exerted directly over muscle tendons. Similarly, a tool such as a scissors that are not kept sharp can result in tendinitis or tenosynovitis due to the increased amount of pressure over the tendons of the digits. Evaluating a worker carefully by observing their body posture may reveal a faulty tool or control. Examples include:

Static loading of arm and shoulder muscles

Awkward hand position, especially wrist deviation

Excessive or continuous pressure on the palm and fingers

Exposure to vibration and cold from power tools

Pinch points with double-handled tools

Handles that requires stretching of the hand to grip or high forces to hold.

Tool induced postures can also be the cause of CTD's. For example, the location of the handle may force the hand and wrist to bend in a manner that is unnatural such as in ulnar deviation and palmar flexion. As previously discussed, the grip strength weakens as any position that deviates from neutral is assumed. For example, when the wrist is extended, grasping power is 100 percent, but pinching or holding power is 50 percent, and manipulative effectiveness is 50 percent. When the wrist is fully flexed, the hand is approximately 100 percent effective for precision manipulation, but has lost approximately 50 percent grip strength compared to the neutral position.

Repetitive finger activity required to operate and triggers on tools can lead to stenosing tenosynovitis crepitans, more commonly known as trigger finger. This occurs more commonly when an excessively large handle or a small hand operates a trigger with only the distal interphalangeal joint while maintaining extension of the proximal interphalangeal joint.

Operating tools that create vibration have also been implicated in the etiology of CTD's. An example includes operating a chainsaw, especially if heavy and gripped too tightly. Prolonged use of tools that cause the hand and arm to resonate at certain critical frequencies may contribute to the degeneration and/or pain in the upper extremity joints. The vibration and firm gripping can constrict blood vessels creating numbness and pallor as well as swelling and reduced grip strength. More common names for this includes white finger syndrome, dead finger syndrome, occupational — Raynaud's, and vibration syndrome. These findings may coexist in patients suffering with carpal tunnel syndrome.

Tool — transmitted forces such as short handled pliers can place an excessive amount of pressure in the palm of the hand and injure the nerves and/or blood vessels resulting in numbness or tingling in the hand. Another example is a paint scraper where excessive force can be exerted into the palm of the hand. Sharp edges of screwdrivers can traction skin and create blisters. This can alter the method of using the screwdriver and excessive force can be transmitted to other upper extremity joints. This type of compensatory movement is the underlying cause of cumulative trauma disorders as eventually, wrist, elbow, shoulder, and cervical spine complaints can result.

Because of the great size, weight, and strength diversity that exist between workers, there is no one correct handle or tool grip size. Also, tools are usually designed for the right-handed individual and do not accommodate for the left-handed population that make up 15 percent workforce. Gender differences also contribute to injury. The use of clothing such as gloves can alter the hand - tool fit and interferes with the tactile sense causing an increase in grip strength use. This can overload the tendons and muscles of the forearm resulting in tendinitis. Similarly, injuries can occur if the grip of the tool is slippery requiring over-gripping. Rubber gloves have been found to reduce grip strength 15 to 20 percent. In general, CTD's may develop when the work demands habitually exceed a worker's capacity to respond to those demands. The solution is to balance work demands with worker capacity.

Concepts such as bending the handle of pliers, using powered hand tools such as screwdrivers, choosing the correct handle orientation such as a pistol grip or an inline handle as well as keeping the tools weight as light as possible for the task will help minimize CTD's. For example, handles and grips should be cylindrical or oval with a diameter of between 30 mm and 45 mm (1.25 to 1.75 inches). This size diameter allows for proper grip control of the tool without sacrificing torque capacity. However, for precision operations, the smaller diameter ranging between 5 and 12 mm (0.2 to 0.5 inches) is recommended. A fluted or textured handle can help tools where higher torque is required. The T-shaped handle provides greater torque with less grip strength required. The average workers hand is approximately 100 mm or four inches across. Therefore, most handle lengths are usually 115 mm to 120 mm (5 inches). The maximum recommended distance between the handles of pliers or, the handle span is between 50 mm and 67 mm (2.0 to 2.7 inches) for both men and women. Avoidance of form fitted handles is recommended as there are too many variations in workers to accommodate the same size or fit. These are recommended only if the same person uses the tool exclusively and the work task does not require multiple positions where re-gripping tool is needed. Spring loaded pliers or scissors can be helpful because the muscles that open the hand are weaker than gripping muscles. The triggers of power tools should be at least 51 mm (2.0 inches) so that two or three fingers can activate the trigger.

CONCLUSION

The objective of this presentation was to offer information that can be used when evaluating job sites for CTDs with an emphasis on carpal tunnel syndrome. CTDs in general, are caused from repetition of biomechanical risk factors that are not being properly accommodated for by the worker. Therefore, a specific date of onset is usually difficult to determine and a delay in reporting for health-care provision is common.

Preventing cumulative trauma disorders can be accomplished by instituting personnel-focused work practices where educational training sessions are offered to workers and their supervisors. Also, redesigning tools, workstations, and jobs can reduce work-related injuries. Combinations of both strategies are important to implement for long-term results. Combining worker selection to fit specific jobs, initiating worker rotations, reducing extreme joint movement, reducing excessive forces, reducing highly repetitive movements and decreasing fatigue will result in a successful ergonomic program.

Regardless of the passive approaches utilized, it is essential that a complete evaluation be conducted to identify underlying conditions and other risk factors. The critical importance in obtaining patient satisfying outcomes is the ergonomic assessment of the patient's work environment for both physical and psychometric stressors. It is not wise to analyze a videotape of a workstation that does not include the injured worker as the subject, as it is much more to important to evaluate the patient doing the job task than some other person. Assemble a meeting with the patient, HRO representative, the engineer, supervisor and/or foreman and review the video. Identifying the harmful mental and physical stressors such as positions or motions involved in a work task and compile a list of ideas from all who are present of possible remedies for these problems. Once a list is completed, the management and the worker have all had a part in identifying the problem areas and cost-effective remedies to the problems can then be entertained for each problem on the list. This is where the engineer and HRO personnel can be of great service. It has been my experience that this last step is critical in allaying fears and concerns of the patient that the recommendations that result from such a meeting will be followed and adhered to and allows all involved to appreciate the problem and solutions.

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QUESTIONS

According to Dawson, which of the following objective findings relate to a poor prognosis regardless of therapeutic approach for CTS?

A. Numbness during sleep
*B. Thenar wasting
C. Tenderness over the carpal tunnel
D. wrist edema

When using a well calibrated Dynonometer to assess grip strength, the average of three trials must not be greater then ____% of each other.

A. 10
B. 15
*C. 20
D. 25

When using the Methods-Time Management system, high frequency cycle time is best defined as:

A. Greater than 30 seconds to complete one cycle, or less than 50% of the cycle time involved performing the same kind of fundamental cycle.
B. Greater than 30 seconds to complete one cycle, or greater than 50% of the cycle time involved performing the same kind of fundamental cycle.
C. Less than 30 seconds to complete one cycle, or less than 50% of the cycle time involved performing the same kind of fundamental cycle.
*D. Less than 30 seconds to complete one cycle, or more than 50% of the cycle time involved performing the same kind of fundamental cycle.

Which of the following conditions is associated with Carpal Tunnel Syndrome?

A. Anorexia
*B. Hypothyroidism
C. Multiple Sclerosis
D. Fibromyalgia

A convenient formula for defining CTD's or CTS

A. Rest + High repetition + proper posture + Force = CTD's
B. Awkward posture + Force + Low Repetition + rest = CTD's
C. No repetition + Force + Proper posture + No rest = CTD's
*D. Force + Repetition + Awkward posture + No rest = CTD's