A Study for Musculoskeletal Disorders of Assembly Line Workers

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Abstract

Musculoskeletal Disorders are usually caused or aggravated by poor work processes and unsuitable working conditions - that involve repetitive or forceful movements or the maintenance of constrained or awkward postures. The condition is characterized by discomfort and persistent pain. Case and Demographic Characteristics for Work-related Injuries and Illnesses Involving Days Away From Work, 2003. U.S" was examined. Causes of musculoskeletal disorders for assembly line workers were carpal tunnel syndrome(CTS), tendonitis, low back pain, and occupational stress. Recommendations of improvement for productivity are redesign of working conditions, exercise, prevent of musculoskeletal disorders and avoiding stress.

keyword musculoskeletal disorder, stress, assembly line

I. INTRODUCTION

Almost any repetitive action can lead to a strain injury. Many people suffer from repetitive strain injuries to their upper extremities. Such actions that can lead to these injuries vary: keyboarding, knitting, assembly line production, etc. The most common of these injuries are well known: tendonitis, carpal tunnel syndrome, tennis elbow, trigger finger, etc.

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Musculoskeletal disorder(MD) is also called repetitive strain injuries (RSI), and is a collective term for a range of conditions characterized by discomfort or persistent pain in muscles, tendons and other soft tissues in the back, neck, shoulder, elbows, wrists, hands or fingers. Every time of movement, the connective tissue has to contract and lengthen. Through injury and repetitive movement, the connective tissue becomes stressed, and pain, numbness, and swelling can occur, eventually leading to loss of movement. Some of the more familiar musculoskeletal disorders are tennis elbow, carpal tunnel syndrome, tendonitis, and writer's cramp.

MD injuries have been recorded since the 1700s but have become more common in modern times with the change in mechanization and lifestyle. Surgery and other medical procedures can improve the condition, but body maintenance and a holistic approach to one's lifestyle it the best long term solution for prevention of carpal tunnel and other musculoskeletal injuries.

The MD affects assembler by repetitive placing, grasping or moving objects. The purpose of this study is to reduce the assemblers' MD for assemblers through risk analysis. The objectives are to review assembly lines and RSI, to investigate statistics and to indicate recommendations.

Ⅱ. ASSEMBLERS' MUSCULOSKELETAL DISORDER INJURIES

The followings give some manufacturing that may lead to musculoskeletal disorders.

(1) electronics assembly workers
(2) car assembly workers
(3) panel beaters
(4) white goods assembly workers
(5) packaging workers
(6) staple-gun operators
(7) welders
(8) scissors makers
(9) shoe assembly workers
(10) lamp assembly workers
(11) brick and tile makers
(12) ceramics workers

The assemblers' MD includes carpal tunnel syndrome, tendonitis, bursitis, tennis elbow, and trigger finger (DeQuervain's syndrome and tenosynovitis). Even the title repetitive strain injuries(RSI) are known under many different names (repetitive stress injuries, repetitive motion disorder, upper extremity overuse injuries, and cumulative trauma disorder).

Carpal tunnel is a condition caused by the pinching of the median nerve as it passes through the tunnel in the wrist on the way to the hand. The carpal tunnel is normally quite snug and there is just barely enough room in it for the tendons and one nerve that have to pass through it. If anything takes up extra room in the canal, things become too tight and the nerve in the canal becomes constricted or "pinched". This pinching of the nerve causes numbness and tingling in the area of the hand that the nerve goes to. The symptoms caused by the median nerve being pinched in the carpal tunnel are called the "carpal tunnel syndrome".

There are many possible contributing circumstances to consider in the contraction of carpal tunnel syndrome (CTS), the most central of

which is tendonitis. The tendons which travel through the tunnel can easily become inflamed with either microscopic or macroscopic lesions, which cause pressure on the median nerve. From the tunnel the tendons travel through synovial sheaths called bursa which keep them lubricated. Tendon inflammation leads to the swelling of the bursa (due to the overproduction of the lubricant synovium), and this in turn causes the synovium itself to become sticky instead of acting as a lubricant. The swelling of the tendons and synovial sheaths exerts pressure on the median nerve in the carpal tunnel. Every time the hand is used, the inflamed tendons travel through the bursa (with the now resistant synovium) which causes even more inflammation in both the tendons and the synovial complex.

Other less prominent contributing factors to CTS are the misalignment of the radius and ulna forearm bones leading to the wrist, a pre-existing trigger finger condition, continued use of objects which vibrate (i.e., a jackhammer, chainsaw, hand-held grinder), having an occupation in a cold environment (decreases blood flow to the affected tissues), wrist fractures, and misalignments of the lower cervical spine.

The swelling of the synovial sheaths is also known as bursitis. While this condition can accompany CTS and is always present with tendonitis, in these cases it is considered more of a symptom and/or side effect than a cause. Usually the only instance of bursitis contracted in the upper extremities, which is labeled as such is in the shoulder area.

Another RSI that is quite common is trigger finger (tenosynovitis). Trigger finger occurs when the tendons and associated ligaments used to operate the index finger and thumb become inflamed or develop scar tissue (nodules). The cause of this condition is the repetition of the tendon traveling across the ligaments. If this occurs near or in the wrist area, it can cause CTS. Other possible contributing factors

include rheumatoid arthritis, partial tendon lacerations, and repeated long hours of gripping things. Symptoms of this condition are a noticeable clicking sound and feeling when closing the thumb and forefinger. If this condition progresses long enough untreated, the forefinger may lock in place while closing and must be manually moved to a different position.

Tennis elbow occurs when either microtears develop in the forearm muscles at the insertion point at the elbow, or when tendonitis develops at the elbow. In the former, overextension and/or rotation of the forearm is usually the cause with few, if any, mitigating circumstances causing contraction. In the latter case, direct blows to the elbow and excessive tensile forces can be a contributing factor.

Occupational stress results from negative harmful stress or distress. The more obvious forms of stress are severe stress reactions from exposure to trauma and/or violence at work. This is often referred to as critical incident stress.

More subtle forms of stress may arise as a result of:

(1) Unrealistic workloads and deadlines;
(2) Shiftwork;
(3) Long work hours;
(4) Job insecurity;
(5) Lack of understanding of the job;
(6) Lack of control over workload;
(7) Poor communications between management and employees;
(8) Hazardous working conditions;
(9) Working with persons who are sick, injured or dying;
(10) Handling complaints, dealing with abusive customers;
(11) Poor job placement;
(12) Lack of job satisfaction;
(13) Repetitive, unstimulating tasks.

Most of the above contributing factors are easily rectifiable once the signs and symptoms have been identified.

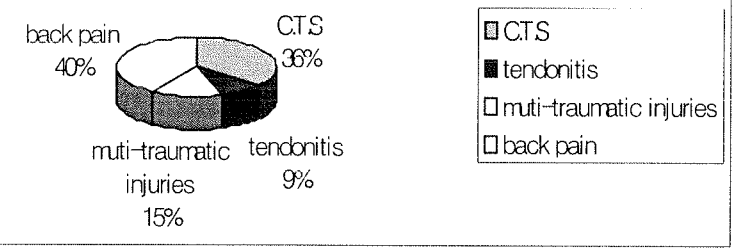
Ⅲ. ANALYSIS OF INJURY

3.1 Review of Statistics

"Case and Demographic Characteristics for Work-related Injuries and Illness Involving Days away from Work, 2003. U.S" was examined.

[Figure 1] shows affected upper extremities for assemblers. The back pain and C.T.S. took account for 40% and 36% out of total injuries of upper extremities, relatively. The tendonitis took account for 9% out of total injuries of upper extremities.

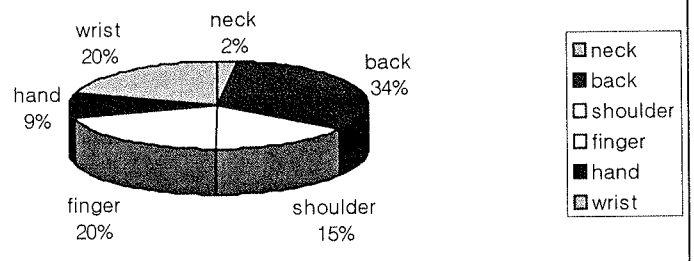
[Figure 1] Assemblers' upper extremity injury



[Figure 2] shows injured body part for assemblers. The injuries of back and shoulder took account for 34% and 15% out of total upper extremity injuries, relatively. The injuries of wrist and hand took account for 20% and 9%, relatively. Also, The injuries of finger took

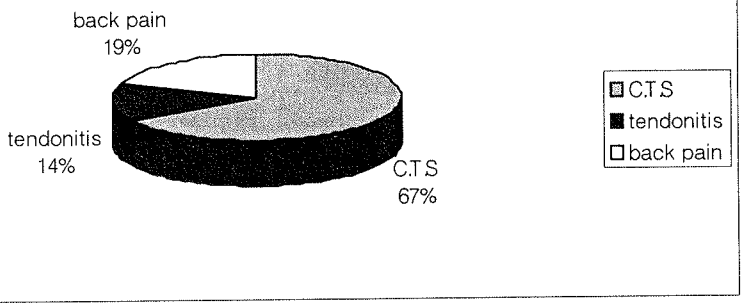
account for 20% out of total upper extremity injuries.

[Figure 2] Injured body part for assemblers



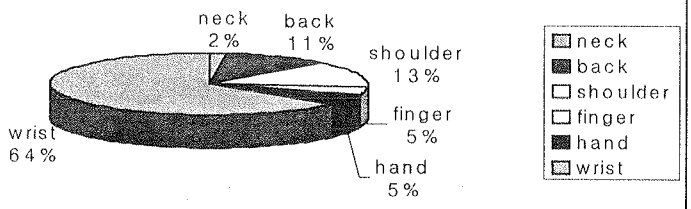
[Figure 3] shows nature of injuries in repetitive motion. The injuries of C.T.D., back pain and tendonitis took account for 67%, 19% and 14%, relatively.

[Figure 3] Nature of injury for repetitive motion



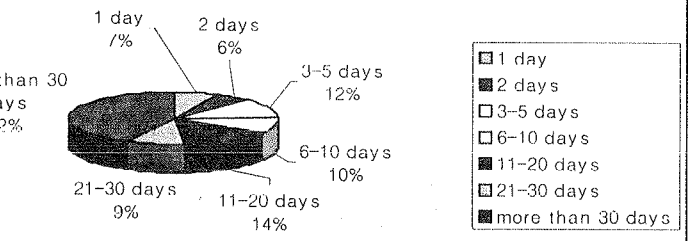
[Figure 4] shows injured body part for repetitive motion. The injuries of wrist and shoulder took account for 64% and 13%, relatively. Also, the injuries of back and finger took account for 11% and 5%, relatively. The injuries of hand and neck took account for 5% and 2% out of total injuries of repetitive motion, relatively.

[Figure 4] Injured body part for repetitive motion



[Figure 5] shows days away from work for repetitive motion. The more than 31 days away from work took account for 42% and 11-20 days away from work took account for 14%. Also, 3-5 day away from work took account for 12%, out of total days away from work for repetitive motion.

[Figure 5] Days away from work for repetitive motion



Ⅳ. RECOMMENDATIONS OF IMPROVEMENT FOR PRODUCTIVITY

The design principles for repetitive hand and wrist tasks are

recommended of improvement for productivity.

(1) Reduce the number of repetitions per shift. Where possible, substitute full or semi-automated systems.
(2) Maintain neutral (handshake) wrist positions:
(3) Reduce the force or pressure on the wrists and hands:
(4) Design tasks so that a power rather than a finger pinch grip can be used to grasp materials. Note that a pinch grip is five times more stressful than a power grip.
(5) Avoid reaching more than 15 in. in front of the body for materials:
(6) Provide support devices where awkward body postures (elevated hands or elbows and extended arms) must be maintained. Use fixtures to relieve stressful hand/arm positions.
(7) Select power tools and equipment with features designed to control or limit vibration transmissions to the hands, or alternatively design work methods to reduce time or need to hold vibrating tools.
(8) Provide for protection of thc hands if working in a cold environment. Furnish a selection of glove sizes and sensitize users to problems of forceful over gripping when worn.
(9) Select and use properly designed hand tools (e. g. grip size of tool handles should accommodate majority of workers).

The other hand tool use and selection principles are suggested.

(1) Maintain straight wrists. Avoid bending or rotating the wrists. Remember, bend the tool, not the wrist. A variety of bent-handle tools are commercially available.
(2) Avoid static muscle loading. Reduce both the weight and size of the tool. Do not raise or extend elbows when working with heavy tools. Provide counter-balanced support devices for larger, heaver tools.

(3) Avoid stress on soft tissues. Stress concentrations result from poorly designed tools that exert pressure on the palms or fingers. Examples include short-handled pliers and tools with finger grooves that do not fit the worker's hand.

(4) Reduce grip force requirements. The greater the effort to maintain control of a handtool the higher the potential for injury. A compressible gripping surface rather than hard plastic may alleviate this problem.

(5) Whenever possible, select tools that use a full-hand power grip rather than a precision finger grip.

(6) Maintain optimal grip span. Optimum grip spans for pliers, scissors, or tongs, measured from the fingers to the base of the thumb, range from 6 to 9 cm. The recommended handle diameters for circular-handle tools such as screwdrivers are 3 to 5 cm when a power grip is required, and 0.75 to 1.5 cm when a precision finger grip is needed.

(7) Avoid sharp edges and pinch points. Select tools that will not cut or pinch the hands even when gloves are not worn.

(8) Avoid repetitive trigger-finger actions. Select tools with large switches that can be operated with all four fingers. Proximity switches are the most desirable triggering mechanism.

(9) Isolate hands from heat, cold, and vibration. Heat and cold can cause loss of manual dexterity and increased grip strength requirements. Excessive vibration can cause reduced blood circulation in the hands causing a painful condition known as white finger syndrome.

(10) Wear gloves that fit. Gloves reduce both strength and dexterity. Tight-fitting gloves can put pressure on the hands, while loose-fitting gloves reduce grip strength and pose other safety hazards (e. g. snagging).

V. CONCLUSIONS

Occupational overuse injuries can be serious and debilitating. Thus, employees might suffer from these injuries often need time off work. Unplanned time off work can cause disruption to business' productivity. Workers' compensation claims for these injuries can be costly.

Therefore, to prevent occupational overuse injuries, generally followings are needed. (1) Avoiding risks in the first place by safe design of plant, work processes, equipment and products. (2) The identification, assessment and control of risks arising from occupational overuse (refer to Conducting a Risk Assessment for advice on how to do this). (3) Providing training and information to employees on correct work methods and postures and the correct use of tools, machinery and other equipment.

As a result of ergonomic adjustments, employees will feel better and visits to health care providers will subsequently decrease over time. In addition, absenteeism of employees is most often reduced and there are fewer complaints among co-workers, which usually results in a better work morale. All of this can be an added economical benefit for the employer. Although this is a simplistic example of what employers can do in their businesses, often these types of alterations in the workstation design are overlooked or ignored.

REFERENCES

[1] 국내문헌

1) Bureau of Labor Statistics, Case and Demographic Characteristics for Work-related Injuries and Illnesses Involving Days Away From Work, 2003, U. S. Department of Labor.
2) Chengalur, S. N., Rodgers, S. H., Bernard, T. E., Kodak's Ergonomic Design for People at Work, John Wiley & Sons, Inc., second edition, 2004.
3) Davis, P., Prevention of Repetitive Strain Injuries, In particular Carpal Tunnel Disorder, for the Tapestry Artist : A Holistic Approach.
4) Goetsch, D. L., Occupational Safety and Health for Technologists, Engineers, and Managers, Pearson Prentice Hall, 5th edition, 2005.
5) Kim, D.S., Press operator and RSI, Journal of the Safety Management & Science, 6-3, 2004.
6) Kim, D.S, Repetitive Strain Injury on Automobile Assembly Process and Alexander Technique, Journal of the Safety Management & Science, 6-2, 2004.
7) London Hazards Centre, RSI Hazards Handbook, Interchange Studios, Hampstead Town Hall Centre, 213 Haverstock Hill, London NW3 4QP, UK
8) Mogensen, V. (1999), Ergonomic Inaction : Congress Puts OSHAs Ergonomics Standard on Hold.
9) Niebel, B., and Freivalds, A., Methods, Standards, and Work Design, McGraw-Hill, 11th edition, 2004.
10) NIOSH, National Code of Practice for the prevention of Occupational Overuse Syndrome[NOHSC:2013(1994)].
11) Rueqq, D.M., (1999), Repetitive Strain Injury : A Handbook on Prevention and Recovery.
12) http://ergonomics.ucla.edu/oldergo/Ergowebv2.0/articles/commonrs.htm
13) http://www.ergonomics.com.au/lcgmo.htm
14) http://www.ndhsc.gov.au/OHSInformation/NOHSCPublications/factsheets/oos211.htm
15) http://www.nohsc.gov.au/SmallBusiness/BusinessEntryPoint/hazards/overuse/htm