Work-Related Musculoskeletal Disorders of the Upper Limb

Cumulative Trauma Disorders
- Disorders of the muscles, tendons, nerves and blood vessels that are caused, precipitated or made worse by repeated exertions or movements
- Definition reflects workers' compensation rules
- Frequently reported in the upper limbs and necks, but can occur in other body parts

Tendons & Tendon Sheaths

Muscle and Tendon Disorders
- Fatigue
- Myalgia
- Myofascitis
- Tendinitis
- Synovitis/bursitis
- Tenosynovitis
- Stenosing tenosynovitis crepitans
- DeQuervain's disease
  - Washer woman's sprain
  - Epicondylitis
  - Tennis elbow, golfer's elbow

Nerve Disorders:
- Neuritis
- Carpal tunnel syndrome
- Cubital tunnel syndrome
- Guyon's canal syndrome
- Thoracic outlet syndrome

Names for Musculoskeletal Disorders
- Cumulative trauma disorders
- Repetitive trauma disorders
- Repetitive strain injuries
- Occupational cervicobrachial disorders
- Overuse syndromes
- Work related disorders
- Regional musculoskeletal disorders
Musculoskeletal disorders

1. mechanical and physiological process
2. related to work intensity and duration
3. require periods of weeks, months or years to develop
4. require periods of weeks, months or years for recovery
5. poorly localized, nonspecific and episodic
6. often unreported
7. multiple work and personal causes

Taylor (1911) How to increase productivity form 12.5 to 47 tons per man per day

- Our first step was the scientific selection of the workman, ... He was a little Pennsylvania Dutchman who had been observed to trot back home for a mile or so after his work in the evening about as fresh as he was when he cam trotting down to work in the morning.
- We found that upon wages of $1.15 a day he had succeeded in buying a small plot of ground, and was engaged in putting up the walls of a little house for himself in the morning before starting to work and at night after leaving.

- Bethlehem Steel

Well everyone can master a grief but he who has it.
- Benedict in Much Ado About Nothing Act III Scene II
- U.S. News 03/17/97: Effective pain treatments exist but aren’t being used

Elastic Deformation & Fatigue

- Application of a fixed load $F$ causes an object with length $L$ to deform, $\Delta L$
- Elastic deformation occurs instantly as load is applied

Fatigue

Strength

Number of stress cycles (without repair) to failure

Viscoelastic Deformation

- Viscous deformation occurs continuously as load is maintained -- creep
- Excessive deformation may damage tissue or interfere with biological functions

Cumulative Tendon Strain

Strain Limits

Skin Stress-Strain (Kenedi et al. 1967)

Physiological Responses to Tissue Damage

• Inflammation (1-3 days)
  - Cells originating from adjacent tissues

• Proliferation (4 weeks)
  - Randomly oriented fibroblasts & collagen fibers seen first week

• Remodeling (135 days)
  - Collagen fibers proliferate & reorient parallel to the long axis of tendon
  - Tendons heal faster & stronger if they are subjected to regular loading


Localized Fatigue

1. mechanical and physiological process
2. pain and impaired work performance
3. develops in seconds, minutes or hours
4. recovery should be complete within minutes or hours after cessation of work
5. symptoms may be hard to distinguish from those of other disorders
6. workers should seek help if symptoms persist from one day to next or interfere with activities of work or daily living.

Discomfort Patterns

Psychophysical Indices of Fatigue

Areas of Discomfort

Visual Analog Scale for rating overall or body part discomfort

none → worst imaginable
Electromyography, EMG, Often is Used to Assess Fatigue

EMG for a given level of force increases with fatigue

Keyboard Reaction Force

EMG Volts - RMS

Fatigue Curves

Time (s)

Percentage of Maximum Strength (%MS)

Not distinct differences between various musculoskeletal disorders

Localized Fatigue

Chronic Pain

Recognized Pathologies, e.g., CTS

Ramazzini (1713)

Various and manifold is the harvest of diseases reaped by certain workers from the crafts and trades that they pursue. All the profit that they get is fatal injury to their health, mostly from two causes. The first and most potent is the harmful character of the materials they handle. ...... The second, I ascribe to 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 that serious diseases gradually develop therefrom.


Washerwoman’s Sprain

... the tendons of the extensor muscles of the thumb are liable to become strained and their sheaths inflamed after excessive exercise, producing a sausage-shaped swelling along the course of the tendon, and giving a peculiar creaking sensation to the finger when the muscle acts. In consequence of its often being caused by such movements as wringing clothes, it is known as “washerwoman’s sprain.”

DeQuervain’s disease

de Quervain (1895)

DeQuervain’s disease

de Quervain (1895)

Conn (1931) The Legislature in 1929 amended the Ohio Workmen’s compensation act to include tendinitis --- following 12 years of debate

Hammer (1934): Suggested tendons do not tolerate more than 1,500-2,000 exertions/hr

**Early History (cont.):**

**Zollinger (1927):** Swiss insurance claims for 929 cases of crepitant tenosynovitis mostly attributed to repeated strain.

**Obolenskaja and Goljanitzki (1927):** Suggested work rates of 7,600 to 12,000 exertions/shift was a factor in 189 cases of tenosynovitis among 700 tea packers.


**Maeda (1974):**

- First noticed among business machine operators circa 1954.
- "Rationalization" of office work 1950-51.
- 136 case reports 1968-73.


**Maeda (1974) -- more:**

- Harmful factors:
  a) restrained posture
  b) unnatural posture
  c) repeated use of upper limb
  d) static sustaining of the upper limb
- Confusion among clinical doctors between the concept of "occupational disease" from social security standpoint and that of a "professional disease" from medical standpoint.

**Luopajarvi et al. (1979):**

<table>
<thead>
<tr>
<th>Department</th>
<th>n*</th>
<th>Afflicted**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Line Packers</td>
<td>163</td>
<td>56%</td>
</tr>
<tr>
<td>(Rep &gt; 25,000 cycles/day)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shop Assistants</td>
<td>143</td>
<td>14%</td>
</tr>
<tr>
<td>(non-repetitive)</td>
<td></td>
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</tbody>
</table>

* females
** tenosynovitis & peritendinitis


**Fine et al. 1986:**

<table>
<thead>
<tr>
<th>Data source</th>
<th>Plant A</th>
<th>Plant B</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA</td>
<td>0.03</td>
<td>0.1</td>
</tr>
<tr>
<td>Workers' comp.</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Medical absences</td>
<td>3.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Plant medical visits</td>
<td>2.0</td>
<td>14.0</td>
</tr>
</tbody>
</table>

* cases/200,000 work hours


**Survey of 652 Workers at 7 Industrial Sites:**

<table>
<thead>
<tr>
<th>Jobs</th>
<th>Tendinitis</th>
<th>CTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Repetitive -</td>
<td>Low Force</td>
<td>0.6%</td>
</tr>
<tr>
<td>High Repetitive -</td>
<td>High Force</td>
<td>10.8%</td>
</tr>
<tr>
<td>Odds Ratio (plant adjusted)</td>
<td>29.4</td>
<td>14.3</td>
</tr>
</tbody>
</table>


de Krom et al., (1990)

- Community based case-control study (age- & sex-stratified random sample from the population register of Maastricht, The Netherlands, 9/83-7/85 --- n=715)
- Questionnaire survey concerning lifestyle, chronic disease, potential CTS risk factors, & CTS complaints.
- 70% response:
  - 156 cases (131 female & 25 male)
  - 473 controls (310 female & 163 males)

Significant CTS factors
- Duration of activities with a flexed or extended wrist over last five years
- Hysterectomy with ophorectomy
- First menopausal year
- Short height & high weight
- Quetelet index (wt / ht^2)
- Slimming courses
- Varicosis (in men)


Franklin et al. (1991)

- Population based incidence study of occupational carpal tunnel syndrome, OCTS
- OCTS, (ICD 345.0 CTS & 354.1 median neuritis) Washington state 1984-88 workers' comp. claims
- 7,926 cases = 1.74 claims / 1,000 FTE
- Highest rates in hand intensive industries, e.g.,
  - meat, poultry & fish processing 18.2-25.7 / 1000FTE
  - carpentry 11.3
  - egg production 9.6
  - wood products & logging 6.8-9.3
  - state employees 1.6
  - higher education 0.4

- Incidence rate not elevated for office workers, e.g., state employees
- Mean age 37.4 years - does not appear to be an age related problem
- Females: males = 1.2:1 - gender not a significant factor
- Concluded that occupational carpal tunnel syndrome is distinct from that occurring in non-occupational settings.


Smith 1991: Where is the wisdom?

- Medical journals
  - 30,000 grow
  - 7%/yr
  - 1% scientifically sound
- Medical interventions
  - 15% supported by solid scientific evidence
  - E.g., typical glaucoma treatment --- only one controlled study
- Significant variations in practice
  - Colorectal cancer screening
    - experts estimate mortality reductions 0-100%
  - 172 radiotherapist
    - 48% offered palliative treatment to patients with metastasised lung cancer only if they had symptoms
    - 52% always offered it
- Mathematical models offer hope for future

Smith, Where is the wisdom. BMJ 303:799, 1991

Latko (1997)

- Discomfort
- Tendinitis
- CTS (nerve conduction)
- CTS (hand diagram)

Comparison of CTS prevalence (%) with Repetition (0-10)
**Affected Industries & Occupations**

Manufacturing
- Aerospace
- Automotive
- Electronics
- Garment & apparel
- Glass products
- Inspectors
- Marine
- Metal forming
- Plastic molding
- Surface coating

Clerical
- Data & word processing
- Health care
- Retail sales

Agricultural
- Meat processing
- Food processing

Performing arts
- Athletics
- Musicians

**New Repeated Motion Disorders (BLS)**

![Graph showing incidence rate for repetitive trauma disorders](image)

**Incidence Rate for Repetitive Trauma Disorders**
(Cases / 10,000 full-time workers)

- 1976: 0 cases
- 1981: 10 cases
- 1986: 20 cases
- 1991: 30 cases

**Work Hours**

  - [Link](http://www.usnews.com/usnews/issue/971027/27work.htm)

**CTDs - Development & Reporting**

- Environment
- Personal Medical
- Personal Medical Insurance

**1992 BNA Reports**

- January 1, 1992, Vol. 21, No. 30
  Improving statistics on workplace injuries and illnesses is OSHA’s top goal for 1992, agency Administrator Gerard F. Scannell tells BNA. OSHA will propose a rule in early 1992 to streamline and improve employer recordkeeping requirements (p.1084).

- January 1, 1992, Vol. 21, No. 34
  $500,000 annually for five years will be spent by Crane & Co. to reduce or eliminate ergonomic hazards at 11 of its facilities nationwide. The company agrees to spend the money under an agreement settling Occupational Safety and Health Administration citations (p.1180).