REVIEW ARTICLE

Upper limb cumulative trauma disorders for the orthopaedic surgeon

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Summary Work-related musculoskeletal disorders (WRMSDs) of the upper limb have become a serious concern in many countries and have been steadily progressing for several decades. The cause of WRMSD is assumed to be the direct consequence of repetitiveness, extreme postures, and intensive efforts in a problematic psychosocial environment. Therapy should therefore associate the occupational physician and the regulatory bodies. It may be necessary to modify the individual workstation and to reorganize the company. Such upper limb pathologies may be surgically treated but the results are often delayed and poorer when compared to the general population.

Musculoskeletal disorders (MSDs) group different pathologies concerning all the body segments allowing humans to move and work. They have in common the expression of pain with variable intensity.

These disorders of the musculoskeletal structure related to work have particular denominations in the literature. In French-speaking countries, the preferred term is "troubles musculosquelettiques". In the English-speaking countries, the terms "work-related musculoskeletal disorders (WRMSDs)" "cumulative trauma disorders"[1], "repetitive strain injuries", or "occupational overuse syndrome" are in use.

Certain expressions therefore refer to a lesional notion and others to risk factors. These multiple denominations (which suggested an iatrogenic medical construction phase) are related to the relative lack of knowledge of the real causes of these disorders [2, 3]. Since 2000, the acronym WRMSD has garnered consensus.

Epidemiology

The number of salaried workers with MSDs has grown exponentially and spectacularly in industrialized countries over the past few decades.

In France, the data relative to WRMSDs are essentially provided by the French National Health Insurance Fund for
General Health Insurance Scheme : Table 57

Periarticular disorders brought on by certain work-related movements and postures

<table>
<thead>
<tr>
<th>Description of disorder</th>
<th>Treatment time</th>
<th>Restrictive list of work possibly leading to these disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A - Shoulder</strong></td>
<td></td>
<td></td>
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<tr>
<td>Acute tendinopathy with no tear or calcification, with or without enthesopathy of the rotator cuff</td>
<td>30 days</td>
<td>Work including movements or maintaining shoulder in abduction without support (**) with an angle greater than 60° for at least 3.5 h per day accumulated</td>
</tr>
<tr>
<td>Chronic tendinopathy with no tear or calcification, with or without enthesopathy of the rotator cuff demonstrated on MRI (*)</td>
<td>6 months (on condition of exposure lasting 6 months)</td>
<td>Work including movements or maintaining shoulder in abduction without support (**); • with an angle ≥ 60° for at least 2 h per day accumulated or • with an angle ≥ 90° for at least 1 h per day accumulated</td>
</tr>
<tr>
<td>Partial or complete tear of rotator cuff demonstrated on MRI(*)</td>
<td>1 year (on condition of exposure lasting 1 year)</td>
<td>Work including movements or maintaining shoulder in abduction without support (**); • with an angle ≥ 60° for at least 2 h per day accumulated, or • with an angle ≥ 90° for at least 1 h per day accumulated</td>
</tr>
<tr>
<td>(*) or arthro-CT in cases of contraindication to MRI</td>
<td>(**) Movements in abduction corresponding to movements involving releasing arms from body</td>
<td></td>
</tr>
<tr>
<td><strong>B - Elbow</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epicondylitis ± tunnel radial syndrome</td>
<td>7 days 14 days</td>
<td>Work usually including repeated grasping or extension movements of the hand over the forearm or supination and pronation movements</td>
</tr>
<tr>
<td>Epitrochleitis</td>
<td>7 days 14 days</td>
<td>Work usually including repeated adduction or flexion and pronation movements of the hand over the wrist or supination and pronation movements</td>
</tr>
<tr>
<td>Hygromas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- acute hygroma or serous bursas or inflammatory involvement of subcutaneous tissues in the elbow contact zone</td>
<td>7 days</td>
<td>Work usually including prolonged contact on the posterior surface of the elbow</td>
</tr>
<tr>
<td>- chronic hygroma of the serous bursas</td>
<td>90 days</td>
<td>Work usually including prolonged contact on the posterior surface of the elbow</td>
</tr>
<tr>
<td>Ulnar tunnel syndrome (compression of the cubital nerve)confirmation needed by EMG</td>
<td>90 days (exposure time 90 days)</td>
<td>Work usually including prolonged contact on the posterior surface of the elbow. Work usually including forced flexion of the elbow</td>
</tr>
<tr>
<td><strong>c - Wrist, hand, and finger</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tendinitis</td>
<td>7 days</td>
<td>Work usually including repeated or prolonged movements of flexor or extensor tendons of the hand and fingers</td>
</tr>
<tr>
<td>Tenosynovitis</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>Carpal tunnel syndrome</td>
<td>30 days</td>
<td>Work usually including repeated or prolonged movements of extension of the wrist or grasping of the hand or carpal contact, or prolonged or repeated pressure on the heel of the hand</td>
</tr>
<tr>
<td>Guyon tunnel syndrome</td>
<td>30 days</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1** Table 57.

Salaried Workers (Caisse Nationale d’Assurance Maladie des Travailleurs Salariés [CNAMTS]) and the Central Fund for the Agricultural Mutual Insurance Scheme (Caisse Centrale de la Mutualité Sociale Agricole [CCMSA]). These organizations list the WRMSDs recognized as occupational diseases (ODs) in Tables 57(RG) and 39 (RA) (general and agricultural worker funds, respectively): these data only express the number of cases recognized submitting an OD declaration by a salaried worker (Fig. 1).

The other source of information is given by the National Institute for Public Health Surveillance (Institut National de Veille Sanitaire [INVS]), which organizes a dedicated network of epidemiological surveillance in a pilot region: les Pays de la Loire (France) [2].

With a sharp increase over the past 15 years, in 2010 recognized upper-limb and spinal MSDs accounted for 85% of all ODs. In 2010, the French National Health Insurance Fund statistics found a 1.8% growth rate in the number of recognized ODs compared to 2009 (Fig. 2).

Following Table 57, 38,277 cases received compensation in 2009, more than three-quarters of the ODs inventoried by the CNAMTS [4].

In France, the vast majority of recognized WRMSDs come from the secondary sector since, according a CNAMTS study,

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Figure 2 Number of occupational diseases (ODs) recognized by Table 57 of the General Health Insurance Scheme.

only 4% of the recognized WRMSDs are attributable to computer-related work [2].

France is not the only country concerned by the MSD problem. In 2005, 35% of European Union workers considered that work affected their health. The MSDs are the most frequent ODs in Europe. The 2010 European survey showed that 62% of workers perform repetitive upper-limb movements [5].

These pathologies are now found in recently industrialized or developing countries [6].

In France, modification of Table 57 in 1991 cannot alone explain the considerable increase in all sectors. Several phenomena that may explain this increase have been identified [4]:

- the increase in productivity pressures and new organizational methods (globalization, just-in-time methods, quality control, etc.) and their socioprofessional consequences (lack of job security, changes in workstations, work intensification, etc.);
- work intensification, increase in assembly line work;
- automation of a part of the production process, which increases the share of repetitive manual work with low-amplitude movements performed in poor conditions;
- more precise knowledge of work disorders and the improvement of their identification by the National Institute for Occupational Safety and Health (NIOSH);
- better awareness of WRMSD problems on the part of the healthcare actors and salaried workers; the action experts in prevention legitimizes the reality of the risk and increases the number of declarations;
- the increased demands of workers in health matters.

Causes or risk factors?

WRMSDs are multifactorial disorders with an occupational component. Characterization of the risk factors determining these disorders is not simple. The continual progress of the knowledge of the psycho-physio-pathological mechanisms of these ailments are still too fragmentary to propose a validated causal model. However, from research in epidemiology, ergonomics, and biomechanics, it has now been recognized that these risk factors should not be approached in terms of occupation but rather in terms of the actions required by the task and the work context. Problems appear when the biomechanical solicitations are greater than the subject’s functional capacities [2]. The risk factors of WRMSDs can be distributed into two general categories.

Individual factors

Individual factors are related to personal genetic characteristics as well as the subject’s medical history:

- handedness: muscular strength and psycho-sensorimotor dexterity are not identical in the two upper limbs of the same patient;
- gender: WRMSDs are more numerous in women than in men. This difference in prevalence is explained essentially by societal motives: men and women often work in different sectors of activity. Workplaces as well as tools are often designed for men and are not adapted to women. Statistically, women consult earlier for a less severe disorder;
- age: age increases the probability of a disorder because of an accumulation of exposure doses related to the time spent at the work station and a reduction in physiological functional capacities. The working population in most industrialized countries is growing as is the duration of the work life. However, the relation between the duration of exposure and the risk of appearance of the disease is not clear and varies according to the disorder.

Environmental factors

These are biomechanical and psychosocial factors, themselves determined by how work is organized and its context (Fig. 3).

Biomechanical factors

In a work environment, no biomechanical risk factor exists in isolation: they are associated together and vary over time:

- repetitive actions: for the National Institute of Research and Safety for Prevention of Occupational Accidents and Diseases (Institut national de recherche et de sécurité pour la prévention des accidents du travail et des maladies professionnelles [INRS]), repetitiveness is defined by the number of movements per minute in a joint. European and national surveys have demonstrated a very clear increase over the last decade of repetitive movements in the arms and hands in work (62% of salaried workers
during 25% of their work time). Repetitiveness is defined as substantial if the time cycle is less than 30 s or if the activities of the same type are performed for 50% of the work time. This repetitiveness is the risk factor associated with wrist pathologies;

- exertion: excessive exertion exceeds 20% of the maximum strength of the individual. This exertion, particularly in prehension actions, weakens tendons and muscles. Pinch actions solicit them more than grasp actions;
- postures: solicitation of a joint beyond the habitual amplitude has harmful effects independently of the repetitiveness and exertion involved. Norms have been defined and are landmarks aiming to promote postural freedom beginning with the design of the work post by eliminating uncomfortable or dangerous angles (Fig. 4);
- increases in biomechanical solicitations: wearing gloves that are not adapted to the subject’s hand size reduces dexterity. Vibrations increase the antebrachial muscle load and also modify locoregional vasomotoricity;
- cold is associated with a reduction in maximal voluntary contraction. Operators wear gloves for protection;
- inadequate lighting can promote poor trunk and head posture or pressure on the elbows.

Improvements in the ergonomic design of workstations and in the work organization can limit the consequences of these physiological modifications.

**Psychosocial factors and stress**

In a 2010 European study, 56% of salaried workers declared being subjected to excessive working speeds, and among these individuals 40% declared being subjected to stress [5].

There are a number of effects of stress related to WRMSDs: for the same work, exertion is increased. A stressed operator can work too fast, too long, too intensely, without checking the workstation. Functional recuperation is longer. Stress chronically amplifies pain and makes operators more sensitive to risk factors and WRMSDs.

Physiopathological and biological mechanisms interact: the Brussels model incorporates these loops [7,8] (Fig. 5).
The central nervous system (CNS) increases the level of activity in the reticular formation and therefore the muscle tone and the biomechanical load. Stress triggers the release of corticosteroids by the adrenal glands, which can result in edemas and directly promote entrapment syndromes.

Release of cytokines such as interleukins may trigger intra- and peritendinous inflammatory phenomena.

The vegetative nervous system activates catecholamine secretions, which, once released into the bloodstream, reduce blood supply to soft and muscle tissues, and therefore nutrients, thus promoting chronic muscle fatigue and myalgias.

Stress factors should be sought in the subject's home environment but most notably in the work environment. These factors are sources of stress when the worker has a negative perception of them in the work environment.

Organizational factors [4,5]

Organizational factors are difficult to assess. According to the European survey, in the secondary sector, the work pace is determined by the speed of the machine for 18% of workers, and these pace restrictions are present twice as often as in the service sector. The type of tool and the sizing of the workstation are the most frequently found criteria.

When working on a computer screen, biomechanical risk factors present high specific characteristics related to the position of the screen, use of the keyboard, use of a computer mouse, and the time spend using the mouse.

Clinical

MSDs range from fatigue of a muscle chain of the locomotor apparatus to the characterized disorder. Postural fatigue is rapidly reversible if exposure to the risk ceases. Well-characterized disorders demonstrate the existence of a lesional process that requires treatment.

By definition, WRMSDs mainly affect the muscles, tendons, and nerves, i.e., all the soft periarticular tissues [2].

All WRMSDs present common characteristics:

• they result from the application of biomechanical constraints sustained or repeated for more or less long periods of time exceeding the subject’s functional capacity. This is therefore a chronic phenomenon. However, the repetition of an acute phenomenon can also manifest as chronic when recuperation becomes impossible during rest phases;

• they result from biomechanical constraints applied to healthy or previously injured or even already pathological structures;

• the clinical signs are variable but generally include intense pain and functional discomfort;

• the solicitations causing these disorders can exist in occupational or extraoccupational activities;

• these are not the result of an accident: a tear or rupture is not a WRMSD.

The symptoms vary, however, depending on the tissues involved [8,9]:

• muscle involvement: the main stress is the possibly low but prolonged intensity or high intensity beyond 20% of maximal contraction. This leads to disorders involving the functioning of muscle fiber, the seat of biochemical modifications with most particularly a deficiency in glycogen. Myalgia can appear for tasks with an intensity less than 10% of maximal voluntary contraction (MVC). The “Cinderella fiber” hypothesis demonstrated that certain motor units of the trapezius muscle are continually activated during mental load in absence of any associated physical activity. These slow fibers are affected first because of excessive activation and insufficient recuperation time;

• tendon involvement: mechanical constraints that are exerted on tendons are traction and friction forces. Tendon exposure to repeated stresses leads to viscoelastic deformations, micro-ruptures, thickening of the collagen fibers, even microcalcifications of the tendon;

• nerve involvement: compression of the nerve is the main stress to which nerves are subjected. This compression sets off a proliferation of conjunctive tissue of the

![Box 1: Lists of the pathologies considered to be work-related musculoskeletal disorders (WRMSDs) by the SALTSA report](http://dx.doi.org/10.1016/j.otsr.2012.12.007)
epineurium, modifying the microcirculation of blood in the vasa nervorum and polarization;
• bursitis: hygroma of the elbow is a form of chronic bursitis, encysted and organized, through inflammation of the superficial serous bursa located between the skin and the olecranon;
• nonspecific WRMSDs: “nonspecific WRMSD” is the term used for clinical situations whose combination of symptoms does not allow a specific diagnosis. These WRMSDs could account for as many as 80% of all these disorders (source: SALTSA 2000 report).

The 2000 European consensus conference (SALTSA report) proposed a list of different pathologies that could be considered WRMSDs [2] (Box 1).

In France for the year 2009, the majority of ODs involved the wrist and the hand (45%), then the shoulder (32%) and the elbow (19%). In Europe, the same order is found with the carpal tunnel, tendinitis of the rotator cuff, and epicondylitis.

We do not intend to present the clinical viewpoint of each WRMSD listed, whose clinical expression is well known and presents no particular interest, but rather to highlight the aspects that suggest a job-related cause. The most invalidating MSDs warrant a global, social, and functional assessment. Setting up a multidisciplinary consultation, associating the surgeon, the physical therapist, and the specialist in occupational health, is a procedure to develop so as to organize these patients’ treatment in the best conditions possible.

Shoulder

With 32% of all the MSDs, shoulder MSDs rank second and have consistently increased over the past decade, outranking elbow MSDs in 1999. These disorders rank first when considering sequelae, with a mean IPP of 13.6% (6.6% for the wrist), a long work stoppage (240 days versus 124 days for the wrist), and a very high social cost.

In one-third of cases, they are preceded by another WRMSD or precede one [10]. This multilocation is therefore relatively frequent and should always be taken into account during the clinical examination. It should also be included in the therapy plan because the goal is maintaining a functional aptitude at work as much as possible.

Several risk factors have been identified:

• repetitive posture, with the arms raised at shoulder level or above;
• abduction greater than 60° or anterior elevation. Abduction is acceptable from 20° to 60° under certain conditions (norm NF EN 1005-4) and unacceptable beyond 60°;
• maintaining the arms in abduction for at least two consecutive min with no support;
• forced adduction (soliciting the acromioclavicular joint);
• performing highly repetitive movements more than 4 h per day or with cycles greater than 30 s, handling loads heavier than 4 kg;
• adduction movement is a factor of stress of the supracapular nerve and the long thoracic nerve can be injured by carrying heavy loads over long periods.

The absence of pauses and an unfavorable psychosocial environment are factors associated with the appearance of WRMSDs, whose prevalence increases from 8% with two risk factors to more than 23% with eight risk factors.

Management of a rotator cuff lesion in the context of an occupational disorder is therefore a highly frequent situation for the surgeon.

The 1998 SOFCOT Symposium series included 72% manual workers, 19% of whom had experienced a work-related accident or occupational disease.

The 2004 Société française d’arthroscopie (SFA) declared 60% manual workers, 84% of whom used their arms above the horizontal level, including 17% work-related accidents or ODs [11,12].

All the studies on the results of rotator cuff tendinous diseases with or without rupture underscore the negative influence of the occupational etiology. The causes of these poor results are multifactorial, as are the prognostic factors:

• patient: the influence of age is variable. It is preferable to propose reconstructive surgery in distal ruptures of the supraspinatus in patients under 55 years of age, whereas the results of simple acromion reconstruction for the same lesion are superior in subjects over 65 years of age. Informing the patient of the objectives and the time necessary for recuperation is fundamental;
• socioprofessional context: assessing the level of shoulder solicitation is a major part of evaluating the probability of returning to work after reconstructive surgery of the rotator cuff. The statistical studies demonstrate that the difference between the two populations is particularly related to the subjective parameters of the Constant score. Only half of the patients recognized as having ODs return to their occupation despite an equivalent result in terms of strength compared to patients who are not recognized as having an OD. For tendinopathies of the rotator cuff without rupture, the prevalence of occupational pathologies is lower than for ruptures of the cuff: approximately 20% [11]. The existence of an occupational disease lengthens the time before returning to work. The Constant score is lower over the short term but the two populations have a statistically identical long-term result, i.e., when the socioprofessional context is no longer as important;
• lesions: the usual precise lesion work-up should be performed before any surgical act, specifying the location of any tear, its extension, the measurement of the subacromial space, and the assessment of the fatty degeneration of the muscle. These factors have major prognostic importance on the possibility of returning to work in the same job;
• treatment: the time between the appearance of symptoms and treatment has a negative influence on the quality of the result and the length of time before returning to work.

Recent modifications (October 2011) of Table 57A are very important (Fig. 6):

• titles related to the changes in medical and surgical classifications: to date, rotator cuff tear was not on Table 57A; only tendinitis was on this table.
Tendinopathies with calcifications—except for enthesopathies with calcification—were excluded in that no epidemiological study demonstrated a relation between this disease and occupational activity. The presence of micro-calcifications corresponding to enthesopathies is not an obstacle to validation of the diagnosis (circulaire 21/2011 Subject: modification of Table 57A, CNAM document). The reference examination for chronic tendinosis and rotator cuff tear is MRI (or arthro-CT in case of contraindication to MRI). No specific complementary exam is required for the diagnosis of acute tendinosis of the rotator cuffs. Adhesive capsulitis not associated with tendinopathy of the rotator cuff is no longer among the diseases listed in the table;

- time to treatment: to take into account the time before clinical and radiological exams are done, the time to patient management was lengthened with 30 days for acute tendinosis, 6 months for chronic tendonitis, and 1 year for rotator cuff tears;
- exposure time: epidemiological studies demonstrate that the probability of rotator cuff tendinopathy increases with exposure time. The statistics retained are 6 months for chronic tendonitis and 1 year for cuff tear. No exposure time was determined for acute tendonitis given the conditions of onset;
- restrictive list of work: only the biomechanical factors for which objective scientific data are available were retained with two determining factors: abduction of the shoulder at 60° or greater and the duration or repetition of the effort.

Also retained were:

- for chronic tendonitis and rotator cuff tear, work including movements or maintaining the shoulder in abduction:
  - at 60° or more for a total of at least 2 h a day;
  - for chronic tendinitis, a 60° abduction angle lasting 3.5 h, corresponding to half of the work day duration in France.

Certain rare tunnel syndromes in the cervicobrachial region can be associated with WRMSD even though not included in Table 57 and the SALTSA (European Agency for Safety and Health at Work) standards. Their symptoms can be responsible for a pain syndrome of the shoulder or present as a pseudotear of the rotator cuff:

- thoracic outlet syndrome (TOC);
- suprascapular nerve (SSN) involvement;
- accessory spinal nerve (XI) involvement;
- long thoracic nerve involvement;
- axillary nerve involvement.

Elbow

The proportion of elbow pathologies is stable, as is their distribution in Table 57B.

Lateral epicondylitis is the leading cause of elbow pathology (83%) and the second-ranked cause of tendinopathy in ODs, followed by medial epicondylitis (11%), ulnar nerve syndrome (5%), and finally hygromas (1%).

Lateral epicondylitis

The cause—effect relation between a repetitive task and the appearance of epicondylalgia has been the subject of several studies [13–15]. This is an insertion tendinopathy in which degenerative and microtraumatic lesions may be promoted by different risk factors [16]:

- application of high tension (weight > 4 kg or static work > 20% of maximum strength)

Figure 6 Table 57A, modified.
• repeated solicitation of the tendon (actions carried out more than two to four times per minute or with a cycle times < 30 s);
• sustained solicitation lasting for 50% of the work cycle;
• posture described as unfavorable (the function position is 90° flexion, forearm in a neutral position);
• insufficient rest periods and a mediocre psychosocial context.

Exposure to elbow MSD risk factors is particularly high in blue-collar workers and to a lesser degree in white-collar workers, in particular in men. After 50 years of age, more than 60% of the blue-collar population is exposed to at least two risk factors.

Tendinopathy of the epicondylar muscles evolves toward healing in 6–24 months in 80–90% of cases and more or less spontaneously. Surgery remains under debate [17].

Isolated tendinopathy is therefore nota priori an indication for surgery. Only recalcitrant epicondyalgalias can be surgical, provided that the psychosocial context is properly evaluated. In addition, the tendon and possible nerve components must be treated together.

Radial tunnel syndrome
Radial tunnel syndrome is the painful expression of chronic suffering of the deep branch of the radial nerve. This is the third-ranked tunnel syndrome of the upper limb in terms of frequency.

The study of twisting movements is the key to diagnosis and in particular resisted supination.

The associated risk factors are [14,18]:

• exertions greater than 1 kg more than ten times per hour;
• static hand work such as pinching or holding a tool firmly;
• working between 0° and 45° elbow extension, particularly with a forced pronation/supination posture of the forearm.

Conservative treatment is proposed as first-line treatment. In case of functional treatment failure; the efficacy of surgical neurolysis via the dorsolateral approach has been validated [14].

Medial epicondylitis
Ten times less frequent, management of medial epicondylitis is the same as lateral tendinopathy. No study assessing treatments is available.

Elbow ulnar nerve syndrome
This is the second-ranked tunnel syndrome in terms of frequency [19–21]. It is stable, accounting for approximately 1% of ODs. The main risk factors associated [14,18] are prolonged static carrying, forced flexion/extension, and possibly vibrating tools. A relation with medial epicondylitis is sometimes found and it then appears as a “second-line” pathology.

In absence of motor impairment, medical treatment associated with modifying flexion/extension amplitudes of the elbow should be considered within a reorganization of the workstation.

Hygromas
Acute or chronic hygromas of the serous bursas of the elbow, although frequent in jobs with direct contact of the elbow with hard surfaces, are not often declared as ODs (100 times less than epicondylitis).

Recent modifications (August 2012) of Table 57B are less important:

• titles related to the changes in medical and surgical classifications: lateral epicondylitis ± radial tunnel syndrome. An electromyogram (EMG) is not mandatory. Elbow ulnar nerve syndrome: an EMG is now mandatory;
• time to treatment: the time to patient management is doubled for lateral epicondylitis;
• exposure time: this new notion is only necessary for ulnar nerve entrapment;
• restrictive list of work: there are no real modifications.

Wrist, hands, and fingers
The majority of ODs recognized and compensated concern the wrist, hand, and fingers. Table 57C provides the restrictive list of jobs that may cause these diseases.

Carpal tunnel syndrome
Carpal tunnel syndrome (CTS) is the leading tunnel syndrome of the upper limb [21]. It is the most frequent WRMDS in France, as in other countries. In 2002, CTS accounted for 37% of the ODs that could be compensated in Table 57.

The monitoring program set up by the INVS indicates a 4% clinical prevalence in the wage-earner population in women and 2% in men (7.8% and 3.7% for over-50-year-olds), particularly in blue-collar workers.

CTS accounts for 14% of the ODs in industry and its prevalence can reach 6% in manual laborers [22].

The environmental risk factors retained are: [21–26]:

• repetitive movements in flexion/extension;
• heavy physical work and posture maintained;
• twisting wrist movements;
• use of key grip;
• vibrating tools;
• hyperpressure on the heel of the hand, wrist in extension.

Other personal factors such as smoking, diabetes, and obesity may play a role.

The symptoms described have no particularity: bilateral paresthesias predominating on the dominant side, experienced at night, sometimes corresponding to work times.

Surgical treatment is proposed after failure of conservative treatment or immediately in cases of substantial lesions proved by EMG.

A long preoperative course, the presence of other WRMDs, or thoracic outlet syndrome as part of double crush syndrome are all components with a poor prognosis.

The total number of interventions has progressed by 285% between 1993 and 1999 to reach 127,269 patients in 2008 and has remained stable since then. A survey conducted by the Haute Autorité de Santé (HAS; French National Authority for Health) is currently being analyzed to identify the causes of this significant increase [26] (Fig. 7).
Guyon tunnel syndrome

Guyon tunnel syndrome is referenced in Table 57. Yet this is a rare disorder, with very few studies in the context of occupational risk factors [21]. Only prolonged pressure on the heel of the hand and percussion on the hypothenar eminence can be implicated.

Tendinitis of the wrist and fingers [16,27–29]

Symptoms of tendinitis of the wrists and fingers are nonspecific. The wrist classically houses tendinopathies of the ulnar flexor the radial flexor of the carpus, the ulnar extensor of the carpus, the radial tendons, tenosynovitis of the flexors responsible for trigger finger, and Wartenberg syndrome.

Computers are the cause of specific risk factors: exaggerated finger pressure from striking the keyboard, hyperextension of the wrist in number pad keying, and mouse use in absence of an ergonomic interface [5]. Repeated use of cell phone keyboards for writing text messages is a source of specific pathology that is on the rise.

Tendinitis of the long abductor/short extensor of the thumb de Quervain tendosynovitis [30] has been somewhat better studied than other regional disorders. The associated

Figure 7  Annual number of cases of neurolysis of the median carpal tunnel nerve (direct and video-surgery).

Figure 8  Organization of prevention procedures.

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risk factors are age, female sex, bent wrist postures, and screwing and unscrewing movements.

Prevention

The epidemiology of MSDs observed over the past 30 years warrants development of primary prevention of these disorders given the solid arguments as to the effectiveness of occupational risk factors. The principles of a preventive policy are easily available and enjoy broad scientific consensus [4].

Prevention is applied in two phases: a screening phase leading to, if necessary, the second interventional phase, within an ergonomic context. The therapist is not directly associated with this procedure, which for the most part involves an expert from a specialized organization and the occupational physician (Fig. 8ab).

- the screening phase includes the use of a check-list (the United States Department of Labor’s Occupational Safety and Health Administration; OSHA), which takes into account the known risk factors, work organization, and an interview with the company’s occupational physician;
- the intervention phase is decided by the preventors. It is based on an ergonomic procedure aiming to transform work to control WRMDs risk. This procedure is organized in four steps whose goal is to structure the intervention: mobilize, investigate, control, and assess.

Prevention aims to modify the work situation and is based on the three following axes:

- reduction of occupational solicitations (tool modifications, workstation modifications, organization of production, etc.);
- information/education of the company’s workers by the occupational physician;
- maintaining the operator’s functional capacities by undertaking a physical or sports activity.

Conclusion

MSDs are not in and of themselves a diagnosis but a veritable hodgepodge encompassing a number of classic disorders, associated with interlinking physical, mechanical, and psychosocial risk factors.

Epidemiologists, ergonomists, and biomechanics have now understood the repercussions on the individual of all these promoting factors and have developed analytical and preventive strategies that have now been validated.

Practitioners should be prepared for a specific clinical context. A surgical solution can only be proposed after an objective analysis of the workstation and the psychological status of the worker-patient. The participation of the occupational physician and the social organizations is therefore clearly necessary in the end for a beneficial result. Without this precaution, the risk of a modified, disappointing, or deferred result, for the patient as well as the operator, is not inconsiderable.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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