Incidence of ulnar nerve entrapment at the elbow in repetitive work.

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Running head: Ulnar nerve entrapment at the elbow in repetitive work.

Incidence of ulnar nerve entrapment at the elbow in repetitive work.

Objectives: Despite the high frequency of work-related musculoskeletal disorders (WRMD), the relations between working conditions and ulnar nerve entrapment at the elbow (UNEE) has not been the object of much study. We studied the predictive factors for UNEE in a three-year prospective survey of upper-limb WRMD in repetitive work.

Methods: In 1993-1994 and three years later, 598 workers whose jobs involve repetitive work were examined by their occupational health physicians and completed a self-administered questionnaire. Predictive factors associated with the onset of UNEE were studied with bivariate and multivariate analysis.

Results: Annual incidence was estimated at 0.8% per person year, based on 15 new cases during this three-year period. Holding a tool in position was the only predictive biomechanical factor (OR = 4.1, CI 1.4-12.0). Obesity increased the risk of UNEE (OR = 4.3, CI 1.2-16.2), as did presence of medial epicondylitis, carpal tunnel syndrome, radial tunnel syndrome, and cervicobrachial neuralgia. The associations with "holding a tool in position" and obesity were unchanged when the presence of other diagnoses was taken into account.

Conclusions: Despite the limitations of the study, the results suggest that UNEE incidence is associated with one biomechanical risk factor (holding a tool in position, repetitively), with overweight, and with other upper-limb WRMD, especially medial epicondylitis and other nerve entrapment disorders (cervicobrachial neuralgia, carpal and radial tunnel syndromes).

Keys terms: elbow, repetitive work, ulnar nerve entrapment, work-related musculoskeletal disorder.

Upper-limb work-related musculoskeletal disorders (WRMD) are frequent in industrialized countries, especially tendinitis and nerve entrapments. Ulnar nerve entrapment at the elbow (UNEE), also called "cubital tunnel syndrome", is usually considered as the second most common nerve entrapment disorder, after carpal tunnel syndrome (1).

While some authors (2) consider UNEE difficult to diagnose, even with EMG, definitions based on symptoms and signs are available for epidemiologic studies (2,3). Nonetheless, as Bozentka mentioned in his physiological study of UNEE, epidemiologic studies of occupational UNEE are quite rare (4). Most of the occupational studies are case reports in specific occupations or sectors, such as driving (5), shoes industry (6,7), bamboo toy factory (8), surgical suture thread factory (9), workers exposed to hand-operated vibrating tools (10,11), and professional musicians (12). Most of them do not include an assessment of exposure to biomechanical factors.

This study was based on data from a national survey that focused on work-related upper-limb disorders in general, with two medical examinations for each worker (1993-1994 and 1996-1997). The survey has been described in previous articles about carpal tunnel syndrome, wrist tendinitis and epicondylitis (13-15). We analysed UNEE with a longitudinal approach and looked at various predictive factors for its onset, including the presence of other WRMD.

Subjects and methods

Subjects

The sample in this study has been described in previous papers (13-15). In 1993-1994, 1420 workers whose occupations required repetitive work and 337 who did not perform repetitive work completed a self-administered questionnaire and were examined by the occupational health physicians in charge of the medical surveillance of the workers in their companies. These subjects were selected according to occupational criteria. Those with repetitive work belonged to one of the following activity sectors: assembly line (packaging excluded), clothing and shoes industry (packaging excluded), food industry (packaging excluded), packaging, supermarket cashiers. Except the supermarket cashiers, they were classified in 111 different "working situations", defined as subgroups experiencing similar working conditions at a common work location (most often, the same workshop or the same assembly line). Three years later, 18 of the 39 physicians of the initial survey could repeat it; they had examined 700 workers in repetitive work in 18 different firms. Of the 700 workers, 102 (15%) were completely or partly lost to follow-up. The present study is based on the 598 workers in the longitudinal study. Most had the same or a similar job at baseline and three years later.

Medical variables

Guidelines prepared for the survey were used in the standardized clinical examination performed by the occupational physicians at the beginning of the study and again three years later. A list of criteria for the diagnoses recorded in the medical questionnaire was prepared for this survey. The guidelines covered 33 diagnoses at the beginning of the study and 35 at follow-up (the slight changes between the two lists were limited to shoulder tendinitis). One or two regional meetings with the occupational physicians took place before the baseline study. Training for the standardised physical examination was included in these meetings. The presentation of the guideline was included again in the regional meetings organised before the second survey.

The diagnosis of UNEE was based upon the following criteria:

- Sensory and motor symptoms in the ulnar nerve distribution,
- Difficulties in moving the elbow,
- Oedema at the elbow,
- Worsening of the symptoms by compression of the cubital tunnel,
- Weakness and clumsiness of the hand.

Emphasis was given to two criteria: sensory symptoms in the ulnar nerve distribution and worsening of the symptoms by compression of the cubital tunnel. Diagnoses were classified in three categories: (i) proved diagnosis in the medical examination (all criteria met), (ii) proved diagnosis before the medical examination (for example, previous diagnosis by a specialist), and (iii) suspected diagnosis (not all the criteria met in the medical examination or diagnosis based on the description of symptoms no longer present at the time of examination).

Our definition of a case of ulnar nerve entrapment included proved, suspected and prior diagnoses. “Prior diagnosis” in the second questionnaire included cases that had appeared during the three-year interval. In the analysis of predictive factors of onset, the sample was restricted to workers not diagnosed with UNEE at baseline. Definitions were based exclusively on the results of the medical examination. The answers to the arm diagram and the description of symptoms in the previous six months issued from the self-administered questionnaire were not taken into account in the analyses. However, these answers were checked for the “suspected” cases, in order to verify that the symptoms were consistent with the diagnosis.

Potential risk factors

The list comprised personal and occupational variables, postures and biomechanical constraints (self-assessed) and psychosocial work factors. It was based on the results from other studies on work-related upper-limb disorders, with a special emphasis on risk factors for elbow disorders.

Personal and occupational variables:

- Gender
- Age, in four categories (<30, 30-39, 40-49, >50 years)
- Occupational variables: activity sector (of the 6 possible) and number of years on the job (<1, 1-9, >10years)
- Smoking (non-smoker, smoker, ex-smoker)
- Body mass index (BMI): normal (BMI<25kg/m^2), overweight (BMI ≥ 25kg/m^2 and <30kg/m^2), obesity (BMI≥ 30kg/m^2)
- Leisure activities: answer to the question: "do you often spend time participating in sports, playing music, on do-it-yourself house projects?", in two categories: yes or no
- Presence of psychosomatic or depressive problems, according to the answers to the following questions: do you often have headaches; do you often have sleep disorders; are you often bothered by your heart beating hard; do you have personal worries that get you down physically; are you in low or very low spirits most of the time; are you bothered by nervousness; do you often feel that nothing ever turns out the way you want it to; do you sometimes wonder if anything is worthwhile anymore. Three categories were defined: no problem, some problems (1 or 2 positive answers), problems (3 to 8 positive answers).

Postures and biomechanical constraints. The job duties mentioned in the self-administered questionnaire included the following actions: "hold in position", "turn and screw", "work with force" (any action performed with force), "use elbows for support", and "hold a tool in position" (use a tool that needs to be held in position). Two categories were considered: whether the action was performed repetitively or not. "Using a vibrating tool" was also considered as a two category variable, irrespective of frequency. As for other questions about working conditions, the answers to postures and biomechanical constraints were checked with the physician.

Psychosocial work factors. Job control (scored from 0 to 8) was calculated as the sum of the following yes or no items: no choice for timing of breaks; unscheduled short breaks not possible; pace dictated by the machine, by colleagues, by other constraints; no control over the quantity of work; no control over the pace of work; lack of variety of work. A low level of job control was defined as a score of 5 or more.

A low level of satisfaction was defined as a negative answer about either satisfaction with the workstation or general job satisfaction.

Other WRMD. The disorders considered in the study were those affecting the elbow, and nerve compression disorders: lateral and medial epicondylitis, cervicobrachial neuralgia, median nerve syndrome at the elbow, radial tunnel syndrome at the elbow, carpal tunnel syndrome. Shoulder tendinitis was also considered, since workers affected by shoulder pain may modify their motions at

work. Guyon's canal syndrome was considered separately, because it is closely associated with UNEE.

Methods

Statistical Analysis Software (SAS) version 8.2 was used for the entire study.

Relations between UNEE in 1996-1997 and risk factors in 1993-1994 were studied for the 578 subjects free from UNEE at baseline, by bivariate associations (chi-square and Fisher test). The variables associated with UNEE at a P-level<0.15 were studied then with two separate logistic models, one with gender, age, and WRMD present at baseline, another one with gender, age, and the risk factors other than WRMD. In a last step, a final logistic model took into account, in addition to gender and age, a limited number of factors most strongly associated with UNEE according to the previous analyses.

It was planned to check the associations between UNEE and Guyon's canal syndrome. However, the diagnosis of Guyon's canal syndrome was absent from the medical questionnaires of all the incident cases of UNEE.

In addition, we looked at the frequency of two variables associated with the incidence of UNEE in the final multivariate model among the prevalent cases in the entire group of 1757 cases (1420 exposed to repetitive work, 337 unexposed) in 1993-1994. Our objective was to obtain additional information about the associations between those risk factors and UNEE, especially since the prevalent and incident cases were completely separate groups.

Factors associated with loss to follow up

Loss to follow up was significantly associated with age and activity sector. It was more frequent among both those younger than 30 years and those at least 50 years of age, and among supermarket cashiers. There was no selection effect according to medical conditions at baseline, except that those lost to follow up more often complained of shoulder pain, with a substantial contribution from the relatively younger subgroup of supermarket cashiers.

Occupational physicians could obtain information on the reason for loss to follow up for 47 of the 102 lost to follow up. The most frequent reasons were parental or maternity leave, resignation, and dismissal. Health reasons were reported less frequently.

Results

Among the 598 workers (420 women, 178 men) in the longitudinal study, 20 (15 women and 5 men) had a diagnosis of UNEE at baseline; 7 of them were affected on the right side, 8 on the left, and 5 bilaterally. Three years later, 18 of the 20 cases had recovered. The five workers with bilateral

UNEE had recovered. In 1996-1997, there were 17 prevalent cases: 10 affected on the right side, 3 the left, and 4 both. Of the 17 cases, 15 were incident cases, making an incidence rate of about 0.8% per person year. Seven of them were classified as "proved in the medical examination" and seven as "suspected" diagnosis. The last one, classified as "proved diagnosis before the medical examination" had undergone surgery for UNEE two years earlier. Among the seven suspected cases, three had paraesthesias exclusively in the fourth and fifth digit according to the self-administered questionnaire. Three had paresthesias also to other digits; for them the occupational physicians had given a diagnosis of carpal tunnel syndrome in addition to UNEE. One had pain at the elbow.

Two physicians had three incident cases, three had two cases, three had one case.

Among the 15 incident cases, 10 were employed in assembly line of household electrical appliances (4 cases), car brakes (3 cases), electronic appliances (2 cases) or ski accessories (1 case). Three were in the shoe industry, two in packaging in the food industry (packaging of bread; sticking of labels in the meat industry).

The factors associated with incidence were studied in the group of 578 workers who did not have UNEE at baseline. Among the potential personal and occupational predictive factors, the bivariate analyses (table 1) indicated that gender, presence of psychosomatic or depressive problems, BMI, "uses elbows for support" and "holding a tool in position" were associated with incidence. These variables, together with age and activity sector, were included in a logistic model. The model (not given) indicated that obesity and "holding a tool in position" were significantly associated with incidence of UNEE. "Support on the elbow" remained in the model with an OR of 3.73, and a 95% confidence interval [0.71 - 19.64].

The associations between the presence of other WRMD in 1993-1994 and incidence of UNEE were studied separately. Medial epicondylitis, cervicobrachial neuralgia, and radial and carpal tunnel syndromes were significantly associated with UNEE incidence (table 2). When these four disorders were taken into account simultaneously in a logistic model, all of them remained significantly associated with UNEE incidence. For that reason, the variable taking into account the presence of other WRMD in the final model was the presence of at least one of these four disorders.

The final logistic model included, in addition to gender and age, the three variables most strongly associated with UNEE: BMI, holding a tool in position and presence of another WRMD. These three risk factors remained associated with incidence of UNEE, as indicated in table 3.

We checked that the frequency of "holding tool in position" , overweight and presence of another WRMD was high at baseline among the incident cases if the definition of incidence was restricted to "proved diagnosis in the medical examination". The frequencies were 57% for "holding a tool in position (31% in the whole sample), 29% for obesity (7% in the whole sample). and 71% for presence of another WRMS in the list (30 % in the whole sample).

Holding a tool in position and BMI were also examined to see whether either was associated with the prevalence of UNEE in the entire sample in 1993-1994. The prevalence was 2.1% (37 cases among

1757 subjects). The association with BMI was of borderline significance (p= 0.051); the prevalence was 9.30% for obese subjects, 2.11% for those simply overweight and 2.42% for those with a normal weight. Prevalence was significantly higher (3.85% *versus* 1.47%, p=0.002) among those who had to hold a tool in position.

Discussion.

Our study suggested that UNEE is associated with occupational risk factors, more precisely with "holding a tool in position", with personal factors (obesity), and with presence of other upper-limb disorders, especially medial epicondylitis and other nerve entrapments. The study had some limitations however, which must be taken into account: the criteria for UNEE were quite similar to those recommended in recent papers (3,4), however there was no confirmatory nerve conduction study performed for the 15 incident cases, and the criteria for "suspected" diagnosis were not explicit; postures and biomechanical constraints were self-assessed; another limitation was the small number of cases.

The study was based entirely on clinical diagnosis. The pressure provocative test, which was one of the criteria needed for proved cases, has a specificity of 0.98, according to a study of the sensitivity and specificity of provocative tests for UNEE (16). "Suspected" diagnosis of UNEE was based on the evaluation by the physician; no minimum number of criteria was given in the guideline. However, for those cases the symptoms described in the self-administered questionnaire were consistent with the diagnosis given by the physician..

In this study postures and biomechanical constraints were self-assessed, but the answers were checked with the physician. In addition, the frequency of each constraint was calculated for each "working situation", and the results were discussed with the occupational physicians in charge of the surveillance in the firms, in order to be sure that, for all the working situations, the description of the working conditions based on the questionnaires was consistent with the "expert opinion" of the occupational physician.

Many occupational physicians were involved in the study; this might have induced observer bias, although there was specific training for the study, intended to improve the comparability of the medical examinations. The 598 workers in this longitudinal study were not selected according to health criteria, and the selection for health reasons between the first and second questionnaires was minimal (15). Most participants, even those who suffered from upper-limb disorders in 1993-1994, were exposed to similar constraints at baseline and at follow-up. Nevertheless, the occupational physicians at firms with a high level of upper-limb disorders volunteered more often for the longitudinal study

UNEE is described by Hagberg et al. as the second most common occupational upper-limb nerve entrapment, after carpal tunnel syndrome (1), and our study confirmed this ranking. This disorder is

nonetheless infrequent, which partly explains the lack of epidemiological data on occupational factors. In a population exposed to repetitive and forceful movements, Pellieux et al. estimated its annual incidence rate at 2.6%, based on claims for occupational diseases (9). Higher prevalence levels have been observed in some studies or populations: 40% in a group of 69 musicians (12), 42.5% subclinical UNEE (increased motor conduction of ulnar nerve at the elbow) among 167 workers who used hand-operated vibrating tools (10).

The only biomechanical factor in the final logistic model was "holding a tool in position". The workers who responded that they were required to hold a tool in position, repetitively, used various tools such as pliers, cutting pliers, shoe rivets, spatula and screwdrivers. "Repetitively" implied an intensive use, since the cycle time was less than 30 seconds for half of the workers, one minute or more for only 28% of them (14). The association with "holding a tool in position" is not mentioned in other studies on UNEE, but those studies focused more on the role of vibrations, including vibrations from sewing machines (in the shoes industry), than on the repetitive use of tools. In our study "exposure to vibrating tools" was restricted to hand-held tools, and "holding a tool in position" seemed to be more important for UNEE than exposure to vibrations issued from a sewing machine (which is met by almost all the workers in clothing and shoes industry). The three incident cases in the shoe industry had to hold a tool in position, repeatedly, in addition to using a sewing machine. In bivariate analyses, UNEE was also associated with "used elbows for support". Many authors report that elbow flexion and extension are involved in occurrence of UNEE (4,17-21). The ulnar nerve enters the cubital tunnel by passing posterior to the medial epicondyle. The boundaries of fibro-osseous cubital tunnel involved in the "cubital tunnel entrapment" in elbow (alternative name for UNEE) are the olecranon and the ulnar collateral ligament laterally, the medial epicondyle with the ulnar nerve sulcus anteriorly, and the cubital tunnel retinaculum (also called Osborn ligament) and the bridging aponeurosis of the two heads flexor ulnar carpi muscle (one of the medial epicondyle muscles) medially (21-25). Anatomic studies explain the effects of repetitive strain on the ulnar nerve at the elbow, which helps in understanding the physiopathology of this disorder (25,26). The association observed between obesity and UNEE may be explained by mechanisms similar to those involved in carpal tunnel syndrome, dealing with the increase of fat and oedema in the cubital tunnel.

The association between UNEE and ulnar nerve entrapment at the wrist (Guyon's syndrome) could not be studied because the ulnar nerve is involved in both disorders. The association with other WRMD was expected, especially medial epicondylitis and carpal tunnel syndrome. The association with other nerve entrapment disorders, such as carpal tunnel syndrome or thoracic outlet syndrome (grouped with cervicobrachial neuralgia in the 1993-1994 examination in our study) was also expected (10,17). The association between UNEE and cervicobrachial neuralgia is difficult to assess: they can easily be mistaken for one another, since the symptoms are partly the same.

The results suggest that workers with one WRMD have an increased risk for another, such as UNEE, especially if occupational risk factors are also present. They require special attention.

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Table 1: Potential risk factors for 3-year incidence of UNEE

		Number of subjects	Number of incident cases	Cumulative incidence %	OR [95% CI] or 95%CI of the %
TOTAL		**578**	**15**	**2.6**	
Gender	Men	173	1	0.6	1
	Women	405	14	3.5	6.16 [0.80-47.21]
Age	<30 years	115	2	1.7	1
	30-39 years	219	5	2.3	1.32 [0.25-6.91]
	40-50 years	192	5	2.6	1.51 [0.29-7.92]
	>50 years	52	3	5.8	3.46 [0.56-21.36]
Activity sector	Assembly line	236	10	4.2	*(2.6%-5.8%)**
	Supermarket cashiers	42	0	0.0	
	Clothing and shoes industry	61	3	4.9	*(3.1%-6.7%)**
	Food industry	140	0	0.0	
	Packaging	99	2	2.2	*(1.0%-3.4%)**
Number of years on the job	<1	203	5	2.5	1
	1 to 10	307	7	2.3	0.92 [0.29-2.96]
	>10	68	3	4.4	1.83 [0.43-7.86]
Smoking	Non-smoker	202	5	2.5	1
	Smoker	325	9	2.8	1.12 [0.37-3.40]
	Ex-smoker	51	1	2.0	0.79 [0.09-6.90]
BMI	Normal	397	8	2.0	1
	Overweight	138	3	2.2	1.08 [0.28-4.13]
	Obesity	43	4	9.3	**4.99 [1.44-17.32]**
Leisure activities	No	281	6	2.1	1
	Yes	297	9	3.0	1.43 [0.50-4.08]
Presence of psychosomatic or depressive problems	No	323	5	1.6	1
	Score 1 or 2	174	8	4.6	3.07 [0.99-9.52]
	Score 3 to 8	81	2	2.5	1.61 [0.31-8.45]
Hold in position	No	206	5	2.4	1
	Yes	372	10	2.7	1.11 [0.37-3.29]
Turn and screw	No	416	11	2.6	1
	Yes	162	4	2.5	0.93 [0.29-2.97]
Work with force	No	248	6	2.4	1
	Yes	330	9	2.7	1.13 [0.40-3.22]
Use elbows for support	No	553	13	2.4	1

	Yes	25	2	8.0	3.61 [0.77-16.95]
Hold a tool in position	No	401	6	1.5	1
	Yes	177	9	5.1	**3.53 [1.24-10.06]**
Use a vibrating tool	No	475	11	2.3	1
	Yes	103	4	3.9	1.70 [0.53-5.46]
Job control	Low level	369	10	2.7	1
	High level	209	5	2.4	0.88 [0.30-2.61]
Satisfaction at work	High level	530	13	2.5	1
	Low level	48	2	4.2	1.73 [0.38-7.90]

** For activity sector, 95% CI of incidence.*

Table 2: Presence of WRMD at baseline and incidence of UNEE

		Number of subjects	Number of UNEE cases	Cumulative incidence %	p= (Fisher exact test)
TOTAL		**578**	**15**	**2.6**	
Shoulder Tendinitis	No	369	8	2.2	NS*
	Yes	209	7	3.4	
Lateral epicondylitis	No	509	12	2.4	NS
	Yes	69	3	4.4	
Medial epicondylitis	No	550	11	2.0	**p<0.01**
	Yes	28	4	14.3	
Cervicobrachial Neuralgia	No	539	12	2.2	*p=0.07*
	Yes	39	3	7.7	
Median tunnel syndrome at elbow	No	567	14	2.5	NS
	Yes	11	1	9.1	
Radial tunnel syndrome at elbow	No	574	14	2.4	*p=0.10*
	Yes	4	1	25.0	
Carpal tunnel syndrome	No	457	8	1.8	**p<0.05**
	Yes	121	7	5.8	

*** NS: not significant**

Table 3: Results from the final logistic model. Factors associated with three years incidence of UNEE
WRMD = upper-limb work-related musculoskeletal disorders

		OR [95% CI]	p=
Gender	Men	1	0.14
	Women	4.93 [0.59-41.27]	
Age	<30 years	1	0.82
	30-39 years	0.68 [0.12-3.91]	
	40-50 years	0.68 [0.2-3.96]	
	>50 years	1.30 [0.19-9.02]	
BMI	Normal	1	0.08
	Overweight	1.02 [0.25-4.12]	
	Obesity	**4.30 [1.13-16.39]**	
Holding a tool in position	No	1	0.01
	Yes	**4.11 [1.38-12.23]**	
Presence of another WRMD	No	1	0.001
	Yes	**5.09 [1.54-16.82]**	
Frequency		**Cases =15**	**Total=578**

The multivariate logistic model includes all the variables in the table.