Clinical Article

Risk factors for ulnar nerve compression at the elbow: a case control study

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Summary

Background. Ulnar nerve compression at the elbow is frequently encountered as the second most common compression neuropathy in the arm. As dexterity may be severely affected, the disease entity can seriously interfere with daily life and work. However, epidemiological research considering the risk factors is rarely performed.

This study intended to investigate whether potential risk factors based on historical belief contribute to the development of ulnar nerve compression at the elbow.

Method. A hospital based case control study was performed of patients that underwent surgical treatment for ulnar nerve compression at the elbow at the neurosurgical department from June 2004 until June 2005. Controls were those patients treated for a cervical or lumbar herniated disc.

The main outcome measure was the presence of ulnar nerve compression at the elbow proven clinically, and electrodiagnostically.

Results. 110 patients with ulnar nerve lesions and 192 controls were identified. Smoking, education level and related working experience were identified as risk factors. Conversely, gender, BMI, alcohol consumption, trauma to the elbow, diabetes mellitus, and hypertension are not risk factors for the development of ulnar nerve compression at the elbow.

Conclusion. Risk factors are clearly defined. In the past many factors have been described, but mostly in surgical series. This study concludes that gender, pre-

vious fracture of the elbow and BMI are not predictive factors for ulnar entrapment neuropathy. However, education and working experience are closely correlated with this entity.

Keywords: Ulnar nerve compression; ulnar neuropathy; risk factors.

Introduction

Ulnar nerve compression at the elbow is frequently encountered [1]. This is especially true in medical practices specialising in peripheral nerve surgery. However, every general physician, orthopaedic surgeon, plastic and reconstructive surgeon, neurologist or neurosurgeon will see some patients with this entity. Since dexterity may be severely affected, the disease entity can seriously interfere with daily life and work. Despite numerous reports describing the treatment of this disorder and its pathophysiology, its exact incidence and prevalence is still unknown. In a recent report, the standardised yearly incidence is estimated at 20.9 per 100,000 [7]. It occurs most frequently at the end of the fifth decade [1].

Based mainly on surgical series, risk factors have been identified. For example, male gender and fracture of the elbow predisposes the development of ulnar nerve compression at the elbow [1, 5, 6, 9]. However, most of the reported risk factors have not been the subject of epidemiological studies. With this in mind, a hospital based, case control study has been designed to define risk factors for the development of ulnar nerve compression.

sion at the elbow. We believe this to be the first study of this kind in the literature.

Patients and methods

The study protocol was approved by the ethics committee of the Radboud University Nijmegen Medical Centre.

Risk factors

After review of the literature, several factors that have been associated with the development of ulnar nerve compression were identified. These included gender, body mass index (BMI) divided in quartiles, smoking, daily/weekly consumption of cigarettes and alcohol, occupation, repetitive arm motion, level of education, sporting activities, hobbies, previous fracture of or around the elbow, previous subluxation of the elbow joint, diabetes mellitus, hypothyroidism and hypertension.

Data and data collection

Information about these items was gathered using a slightly modified questionnaire, that has been previously validated [14]. These questionnaires were sent to all eligible patients including the control group. A reminder letter was sent to all non-responders in an attempt to maximise data collection.

The following factors were calculated from the data given by the respondents: (1) BMI was calculated as body mass divided by the square of the height. (2) To describe occupation, work was categorised according to the British Standard Occupational Classification 2000 (Table 1) [10]. The number of the category was multiplied by the length of time in years in that occupation and the sum of all these products was divided by the total time (in years) that a person had worked to indicate a categorical estimation of the total working history. Management, light manual labour (categories 1–4, 6, 7)

and heavier manual labour (categories 5, 8, 9) were treated as separate groups.

Definition of patients and controls

The clinical group included those patients who underwent surgical treatment for ulnar nerve compression at the elbow at the neurosurgical department of the Canisius Wilhelmina Hospital, Nijmegen, Netherlands from June 2004 to 2005. Compression of the ulnar nerve at the elbow was made on clinical and neurophysiological grounds as previously described [2].

Patients treated for symptomatic herniated cervical, thoracic or lumbar disc served as controls. These patients were deemed to be suitable controls as there is no recognised relationship between disc herniation and ulnar nerve compression at the elbow. In this control group, concurrent symptoms and signs of ulnar nerve compression in the arm were absent. However, electrophysiological documentation of normal nerve function at the elbow was not obtained. Controls patients did not have a history of prior surgery for ulnar compression at the elbow. The referral pattern of these patients to the neurosurgical department is similar to that of the clinical group.

To generate clinical and control groups of approximately equal size, the study period for controls was restricted to a period extending from December 2004 to June 2005. The odds ratios were calculated by dividing the odds of risk exposure in the two groups.

Statistical analysis

The data from the questionnaires were organised in a database. Statistical analysis was performed using SSPS 11.5 (Lead Technologies). Logistic regression was used for estimating the odds ratio of the various possible risk factors. The chi-square test was used comparing non-parametric data. Statistical significance was reached when $P < 0.05$.

Table 1. Classification of work according to British Standard Occupational Classification [10]

Group	Description	Examples
1	managers and senior officials	directors, senior officials in local government, officers in armed forces
2	professional occupations	chemists, engineers, medical practitioners
3	associate professional and technical occupations	laboratory technicians, architectural technologists, nurses, artists
4	administrative and secretarial occupations	credit controllers, library assistants, telephonists
5	skilled trades occupations	farmers, gardeners, pipe fitters, cooks
6	personal service occupations	nursing auxiliaries, playgroup leaders, hairdressers
7	sales and customer service occupations	sales and retail assistants, call-centre operators
8	process, plant and machine operatives	food, drink, and tobacco process operators, electroplaters, van drivers
9	elementary occupations	farm workers, packers, waitresses, cleaners

Results

In the study period, 110 patients were surgically treated for ulnar nerve compression at the elbow, 45 for cervical disc disease and 147 patients for lumbar disc disease. Thus, a total of 110 clinical and 192 controls were included in the study. Of the former group, 96 (87.3%) returned the questionnaire, compared to 142 (74.0%) in the control group. In Table 2 a number of baseline characteristics are represented.

All risk factors were amenable to evaluation with the exception of sporting activities and hobbies. Most of the patients were unable to recall the weekly time spent pur-

suing these activities nor could they estimate the number of repetitive arm movements. This data was therefore discarded.

Odds ratios and 95% confidence limits for risk factors are represented in Table 3 in which the risk factors are grouped assuming a link due to causative or biological effect. Therefore, a multivariate calculation was made of all those factors within one group.

When examining general factors, neither gender nor BMI were found to be potential risk factors. The odds ratio for gender does indicate a higher incidence of ulnar nerve compression in males but the confidence limit does not support this conclusion. The same holds true for increased weight.

The majority of smokers (121 = 72.9%) used their dominant hand for smoking. Within the study group, there is no correlation between hand preference when smoking and the side of operation ($P = 0.247$), nor does a relationship exist between hand dominance and the side of operation ($P = 0.663$). While smoking itself is a risk factor for the development of ulnar nerve compression at the elbow, the number of cigarettes smoked does not appear to be related to the incidence of nerve

Table 2. Baseline characteristics. Continuous data are represented as mean $\pm$ standard deviation

	Clinical group	Control group
Gender (m/f)	55 (57.3%)/ 41 (42.7%)	65 (45.8%)/ 77 (54.2%)
Age (years)	50.3 $\pm$ 12.5	50.1 $\pm$ 12.9
BMI	26.86 $\pm$ 4.27	26.17 $\pm$ 4.17
Smoking	79 (82.3%)	87 (61.3%)
Alcoholic drinking	86 (89.6%)	122 (85.9%)
Total number	96	142

Table 3. Possible risk factors and calculated odds ratio (OR), 95% confidence limit (CL) and exact P value

Factor	OR	95% CL	P value
General			
Gender (m/f)	1.59	0.94–2.68	0.082
BMI quartiles	1.12	0.89–1.14	0.343
Age	1.00	0.98–1.02	0.917
Gender + BMI quartiles + age	1.54 + 1.08 + 1.00		
Intoxications			
Smoking (y/n)	2.94	1.58–5.48	0.001
Number of cigarettes	1.00	1.00–1.00	0.501
Drinking alcohol (y/n)	1.41	0.63–3.16	0.405
Smoking + number of cigarettes + alcohol	2.99 + 0.999 + 1.398		
Working history			
Total working experience (TWE)	1.25	1.10–1.42	0.001
TWE corrected for education	1.16	0.99–1.34	0.062
Division light – heavy labour (DLH)	2.23	1.31–3.80	0.003
DLH corrected for education	1.63	0.91–2.91	0.103
Education ¹	1.45	1.16–1.81	0.001
Academic/Higher vocational/ Middle vocational/Lower vocational/None			
Local abnormalities			
Repetitive movement of arm during last job	1.1	0.66–1.85	0.712
Fracture elbow	1.52	0.55–4.21	0.417
Luxation of elbow	0.74	0.07–8.24	0.804
Repetitive + fracture + luxation	1.09 + 1.51 + 0.75		
Systemic diseases			
Diabetes mellitus	1.75	0.61–5.00	0.294
Hypothyroidism	0.41	0.08–2.02	0.273
Hypertension	0.78	0.42–1.44	0.421
Diabetes + hypothyroidism + hypertension	2.24 + 0.36 + 0.71		

¹ The academic education has the lowest odds ratio. With each step downward in the list the risk is increased by the OR.

compression. Alcohol consumption is also not a risk factor for developing ulnar nerve compression.

The total working experience, defined as the sum of each individual work experience multiplied by the time in that particular work experience, divided by the total duration that someone has worked, appears to be a risk factor. The minimum score is 0.0 and the maximum 9.0. Work history depends only on the type of work performed because the total working history is corrected for by the number of years a person has worked. Similarly, the role of education as a risk factor is corrected for by the fact that jobs with a higher number in the British Standard Occupational Classification 2000 (Table 1) are the ones for which lower levels of education are needed and in which physical activities are greater. Thus, occupation itself is not a risk factor, whereas education probably is relevant. A closer look at the total working experience may suggest that higher levels of education do indeed decrease the risk of ulnar entrapment at the elbow and logically, occupation can be related to the level of education.

Localised pathological processes at the elbow do not appear to contribute to the incidence of ulnar nerve compression. The 95% confidence limits for fracture and subluxation are wide and may be attributed to the small numbers of patients and controls with these problems. However, a strength of a case control study is, that it is the only useful alternative for events that are rare [13]. It should be emphasised that after reviewing the charts and surgical reports of the patients with a history of a fracture of the elbow, none of them had a clear deformity of the elbow.

Diabetes mellitus, hypothyroidism, hypertension appear to be risk factors although the confidence limits do not suggest a significant correlation. Again, the numbers of involved patients may be small, especially for diabetes mellitus and hypothyroidism. Eight persons from the clinical group and seven patients from the control group suffered from diabetes mellitus. Two patients were hypothyroid in each of the groups, whereas 20 persons from the clinical group and 36 patients from the control group suffered from hypertension. It is remarkable that smoking is not a compounding factor for hypertension ($P = 0.370$).

Discussion

Ulnar nerve compression at the elbow is encountered frequently but until recently its exact incidence was unknown [1, 2]. Mondelli performed a retrospective study based on electromyography and estimated the standar-

dised yearly incidence of ulnar nerve compression at the elbow at 20.9 per 100,000 [7]. This figure motivated the authors to design a case control study exploring the aetiology of ulnar nerve compression at the elbow. To our knowledge, this is the first hospital based case control study investigating this issue.

Several risk factors have been identified in this study. A number of these have been described in retrospective cohort studies, but in the absence of a control arm, questions arise as to the strength of the correlation between risk factors and ulnar nerve compression put forth in these publications. The following serve to highlight this point [1–3, 8]. Many reports state that male gender predisposes to the development of ulnar nerve compression at the elbow. In our study, gender and BMI (even if we divide the score in quartiles) do not meet the threshold for risk factors. A possible explanation for this discrepancy may lie in the fact that men previously performed heavier labour than women. However, even if gender and total working experience are combined, the odds ratio does not change (odds ratio for total working experience remains 1.25) and as such gender cannot be considered a risk factor.

Some authors have found that women with a lower BMI had a greater likelihood of developing ulnar nerve compression [3, 11], whereas others have reported that this occurred irrespective of the BMI [4]. Our study supports the concept that BMI, gender and nerve compression are independent variables.

In accordance with other studies [12] smoking was found to be a risk factor for the development of ulnar nerve compression. This is. The biological substrate is unclear and there was no evidence of a dose – response relationship. Nevertheless, it is possible that the effects of smoking on the microvasculature may reduce the likelihood of recovery in a damaged nerve. Alternatively, it may be postulated that the repetitive movement involved with smoking (flexing and extending the elbow) may predispose to nerve compression. However, smoking hand dominance is not correlated with the side on which surgery is performed, nor the amount of cigarettes smoked daily. Regular alcoholic consumption is not a risk factor as has previously been reported [12].

Heavy work is also a risk factor. If occupation is corrected for total duration of work, it is clear that jobs requiring heavier labour (higher score on the classification of work (Table 1) are associated with a greater risk of developing ulnar nerve compression at the elbow. This holds true even when work is subdivided into light and heavy labour. If work experience is adjusted for

highest level of education, then the level of education is most relevant. This analysis reveals that a lower level of education predisposes to an increased risk of ulnar nerve compression at the elbow; it seems reasonable that occupation and highest level of education are closely related. In the future, we propose to investigate level of education and work experience in relation to ulnar nerve compression at the elbow.

We found that a fracture of the elbow does not predispose to an ulnar nerve compression at the elbow. Although the odds ratio does suggest an influence, the 95% confidence limit clearly contradicts this conclusion. The number of patients in the clinical and control group does not explain this contradiction. Therefore, in the current study no evidence was found that an elbow fracture and development of ulnar nerve compression at the elbow are related. This is also of historical interest, since the alternative term "tardy ulnar palsy" was given to this condition based on the belief that it occurred after a fracture of the elbow [5]. Admittedly, the descriptions of selected cases without a control group does support this correlation [6].

Repetitive movement of the arm during work is not a risk factor. The data required to answer this specific issue is difficult to acquire. The problem is the precise definition of repetitive arm movements and the frequency of such movements. All patients were asked if they made repetitive movements and to provide a description of these movements. The variation is enormous and ranges from typing to operating an industrial machine. Several patients could not recall how many times the movements were performed daily. The data is therefore weak and drawing conclusions from them is difficult. Recently, it has been reported that holding a tool in the same position is a predictive factor [4].

This study could be criticised for its bias. We do not believe that selection bias holds true for our study. Indeed, our clinical and control patients were all selected from those referred to a hospital setting. It is admitted that patients with minimal symptoms relating to ulnar nerve compression have been excluded from the study. However, the exact numbers are not known and therefore the effect on calculations and conclusions cannot be determined. Furthermore, in our practice, the referral pattern for patients with an ulnar nerve compression at the elbow is the same as for those with a herniated cervical or lumbar disc. Conclusions regarding risk could not be formulated for those patients with hypothyroidism and a history of luxation of the elbow because of the small numbers with these conditions.

However, we do not think this is influenced by selection. The possible selection bias in the exclusion of ulnar nerve compression that does not cause severe symptoms or is of only very short duration not warranting surgical intervention is noted. Since exact numbers are not known, we do not speculate about the influence this group has on our calculations and conclusions. Confounding bias is also a common criticism. Prior to this investigation we defined gender as a possible confounder but multiple multivariate regressions did not confirm this assumption.

In our opinion, information bias is not a problem since the patients were questioned regarding actual and very recent habits. The determination of repetitive arm movements whilst working is difficult to assess both in terms of type and frequency. For studies involving the general population, this bias will remain a problem. However, selecting a defined group of industrial workers with a known working history may be helpful in overcoming this problem and may indeed establish whether repetitive movement is a risk factor for ulnar compression.

Finally, the incomplete survey response is a limitation of the study. We cannot know what effect the non-responders may have had on the conclusions drawn from this study.

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Comment

This is a well written paper which describes a relatively small study case control study. The authors are correct to emphasise that education and working experience are closely related and it is observed that the apparent risk factor of work experience is confounded with education level. It would be of interest to see if these results can be replicated in a much larger study, this would also have the advantage of producing tighter confidence limits around the odds ratios and may give stronger results. It would also be of interest examine other predictive factors of ulnar nerve compression in a larger matched case control study.

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