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F. D. BURKE, G. PROUD, I. J. LAWSON, K. L. MCGEOCH and J. N. V. MILES

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# AN ASSESSMENT OF THE EFFECTS OF EXPOSURE TO VIBRATION, SMOKING, ALCOHOL AND DIABETES ON THE PREVALENCE OF DUPUYTREN'S DISEASE IN 97,537 MINERS

F. D. BURKE, G. PROUD, I. J. LAWSON, K. L. MCGEOCH and J. N. V. MILES

*From the Pulvertaft Hand Centre, Derbyshire Royal Infirmary, Derby, UK*

**A consecutive sample of 97,537 miners seeking compensation for Hand-Arm Vibration Syndrome were examined in a medical assessment process which included documentation of age, hand dominance, Dupuytren's disease, years of vibration exposure, history of diabetes, smoking habits and units of alcohol consumption per week. The prime determinant of prevalence of Dupuytren's disease was age, and all other factors investigated were corrected for age. There was no statistically significant correlation between years of exposure to vibration and the prevalence of Dupuytren's disease. There was a statistically significant association with smoking, alcohol consumption and diabetes mellitus, with the heaviest smokers having an odds ratio (OR) of 1.31 (95% CI, 1.17, 1.47), the heaviest drinkers (in excess of 22 units a week) having an OR of 1.59 (95% CI, 1.47, 1.72) and diabetes mellitus patients having an increase in the odds of having Dupuytren's disease of 1.52 (95% CI 1.30, 1.77). *Journal of Hand Surgery (European Volume, 2007) 32E: 4: 400-406***

**Keywords:** Dupuytren's disease: vibration, smoking, alcohol and diabetes

Dupuytren's disease frequently affects males over the age of 65 years in Northern Europe (Gudmundsson et al., 2000). The prevalence of Dupuytren's disease rises steeply with age (Hueston, 1960), with working males in Melbourne, Australia exhibiting a 4% prevalence if younger than 40 years of age, rising to 30% in those older than 60 years of age. There is known to be a genetic predisposition in the majority of cases (Ling, 1963), although sporadic cases are not infrequent. A high prevalence has been noted in diabetics (Leclercq, 2000) with a three to four fold increase over expected rates. An increased prevalence has also been noted in alcoholics, or those with high levels of alcohol intake (Su and Patek, 1970). Exposure to vibration at work has been considered to either be a possible cause or to exacerbate Dupuytren's contracture (Liss and Stock, 1996). This may occur as a result of collagen fibre rupture (Skook, 1948) or palmodigital ischaemia (Kischer and Speer, 1984). Palmodigital ischaemia may arise in the hand as part of the vascular component of Hand-Arm Vibration Syndrome. However, cigarette smoking is also known to reduce circulation in the hand and An et al. (1988) considered there to be an association between smoking and the prevalence of Dupuytren's disease.

This paper assesses the effect of exposure to vibration, smoking, diabetes and alcohol on the prevalence of Dupuytren's disease in over 97,000 ex-miners presenting consecutively for assessment for compensation.

## MATERIAL AND METHODS

A consecutive sample of 97,537 miners seeking compensation for Hand-Arm Vibration Syndrome were exam-

ined in a medical assessment process which included age, hand dominance, a history of types I and II diabetes mellitus, smoking, units of alcohol consumed per week and years of vibration exposure (Lawson and McGeoch, 2003). Clinical examination also included assessment of the hands for Dupuytren's disease, with all stages of the disease from thickening of the palmar fascia to established contractures being considered as cases of Dupuytren's disease. The history and examination was carried out by doctors, inducted into the medical assessment process on a two day training programme. Hand dominance was defined as the hand used for writing. The claimants were asked for details of their previous medical history with specific enquiry concerning type I or II diabetes mellitus.

The claimants scored their own current consumption of cigarettes and alcohol. The data was subsequently categorised by the authors. Smoking was categorised into those who stated they smoked 20 or more cigarettes per day (current heavy smokers); those with a more moderate current usage of less than 20 cigarettes per day (current light smokers); those who were ex-smokers and a final group who had never smoked (described as non-smokers).

Alcohol consumption was categorised into those who stated they drank in excess of 22 units/week (heavy); those with a more moderate intake of 11 to 21 units (moderate); those who drank 1 to 10 units (light) and a final group who did not drink at all (i.e. no units of alcohol consumed).

The claimants were asked for how many years during their employment in any industry they had been exposed to vibrating tools. Enquiry was not restricted to their years working as miners. The assessment simply related

to the total years of exposure, without enquiry into the time during the shift when directly exposed to vibration (the 'anger' time).

We analysed the ability of standardised neurosensory tests used in the assessment of sensory impairment of patients exposed to vibration to predict the diagnosis of Dupuytren's disease. These tests, viz. Thermal Aesthesiometry and Vibrotactile Threshold Tests, (Table 1) were performed and were used to stage the claimants on a modification of the Stockholm Vascular and Neurosensory Grading System (Lawson and McGeoch, 2003) (Table 2). The Thermal Aesthesiometry and Vibrotactile Threshold Tests were performed by technicians trained for the activity on a one and a half day induction programme. The standardised tests were blinded against the results of the history and examination.

In addition, we ran a multifactorial model using all predictors simultaneously. This examines the effect of each variable controlling for the other variables.

In order to examine the effects of vibration exposure, controlling for age, a logistic regression was carried out, using years of exposure as a predictor, with age entered as both a linear and quadratic effect, to ensure that this effect was controlled appropriately. Results are shown as odds ratios (OR), along with the statistical signifi-

cance and 95% confidence intervals. Smoking status was dummy coded, using the four categories – current heavy smokers (defined as 20 or larger number of cigarettes per day), current light smokers (defined as <20 cigarettes per day), ex-smokers and non-smokers. Alcohol consumption was categorised into those who stated they drank in excess of 22 units/week; those with a more moderate intake of 11 to 21 units; those who drank less and a final group who did not drink at all. Non-smokers and non-drinkers were used as the reference category.

**RESULTS**

The age and prevalence of Dupuytren's disease in this population is shown in Table 3. Increasing prevalence with age is confirmed. There was a 1.7% prevalence in miners aged 30 to 34 years of age rising steadily through the age-bands to 21.6% in the 85 to 89 year group.

Dupuytren's disease was confirmed in 8.1% of right hands and 7.2% of left hands in this population. All results in this paper relate to the right hand. No difference of consequence was noted from these findings in the left hand or between dominant and non-dominant hands in any of the parameters studied. Dupuytren's disease was present in 8.3% of right dominant hands,

**Table 1—Scoring system used for thermal aesthesiometry and vibrotactile threshold testing**

Thermal Aesthesiometry (TA) (1°/SEC Index and little finger)			
Temperature neutral zone (TNZ)	<21 °C = 0	≥21 °C <27 °C = 2	≥27°C = 4
Vibrotactile Threshold (VTT) Index and little finger			
At 31.4 Hz <0.3 ms <sup>2</sup> = 0	≥0.3 ms <sup>2</sup> <0.4 ms <sup>2</sup> = 1		≥0.4 ms <sup>2</sup> = 2
At 125 Hz <0.7 ms <sup>2</sup> = 0	≥0.7 ms <sup>2</sup> <1.0 ms <sup>2</sup> = 1		≥1.0 ms <sup>2</sup> = 2

**Table 2—Modification of the Stockholm Workshop Scales**

Stage	Criteria	Assessment	
		Left hand	Right hand
<i>Sensorineural staging</i>			
0 sn	Vibration exposure but NO symptoms		
1 sn	Intermittent numbness and/or tingling with a sensorineural score of ≥ 3 <6		
2 sn (Early)	Intermittent or persistent numbness, and/or tingling, reduced sensory perception with a score of ≥6 <9		
2 sn (Late)	As 2 sn (early) but with a score of ≥9 ≤16		
3 sn	Intermittent, or persistent, numbness and/or tingling, reduced manipulative dexterity and a sn score of ≥19		
<i>Vascular staging</i>			
0 v	No attacks		
1 v	Attacks affecting only the tips of the distal phalanges of one or more fingers – usually a blanching score of 1 to 4		
2 v	Occasional attacks of whiteness affecting the distal and middle (rarely also the proximal) phalanges of one or more fingers – usually a blanching score of 5 to 16		
3 v	Frequent attacks of whiteness affecting all of the phalanges of most of the fingers – usually a blanching score of 18 or more		
4 v	As 3v and trophic changes		

**Table 3—Age and prevalence of Dupuytren's Disease in the right hand (n = 97,537)**

Age band	Dupuytren's disease		
	No	Yes	Percentage (%)
25–29	81	0	0.0
30–34	1673	29	1.7
35–39	10,848	182	1.7
40–44	15,243	400	2.6
45–49	12,694	523	4.0
50–54	11,976	847	6.6
55–59	10,117	1040	9.3
60–64	9957	1445	12.7
65–69	7185	1260	14.9
70–74	5231	1095	17.3
75–79	3414	809	19.2
80–84	1009	246	19.6
85–89	174	48	21.6
90–94	7	3	30.0
95–99	1	0	0.0
Total	89,610	7927	8.1

6.8% of left dominant hands, 6.8% of right non-dominant hands and 7.3% of left non-dominant hands.

The results of the multivariate regression analysis are shown in Table 4.

The prevalence of diabetes mellitus in this group of miners was noted to be 1.2% for all age groups. The prevalence by age band reveals a higher prevalence in older people. The relationship between age, diabetes mellitus and Dupuytren's disease is also shown in Table 4. Diabetes mellitus increases the odds of having Dupuytren's disease by approximately 50% (controlling for age).

The second regression analysis examined the effects of smoking, again controlling for age and the quadratic effect of age (Table 4). Compared with those who have never smoked, ex-smokers had an OR of developing Dupuytren's disease of 1.1, light smokers an OR of 1.3 and heavy smokers of 1.31, a clinically significant increased risk. The greatest effect is time: age has a larger effect than smoking. However, there is a considerable difference between the current smokers (whether light or heavy) and the non-smokers. Considering the interpretation of the parameter estimates from the logistic regression directly, we may say that the relative risk of suffering Dupuytren's if a person is a smoker is about the same as being a year and a half older.

The effect of alcohol on the prevalence of Dupuytren's disease (controlling for age) was also examined using logistic regression and entering age and age<sup>2</sup> in order to control for these variables (Table 4). Compared with non-drinkers of the same age, light drinkers did have a marginally significantly increased OR for development of Dupuytren's disease. Moderate drinkers had an OR of 1.35 and heavy drinkers an OR of 1.59

relative to non-drinkers. Again, these can be interpreted in terms of age, and in terms of the predicted probabilities. Being a moderate drinker increases the risk of Dupuytren's by about the same amount as one year of age, and being a heavy drinker is the equivalent of about two years of age.

The effect of exposure to vibration is small – equal to 1.00, with confidence intervals of 0.998 to 1.005, and is not statistically significant ( $P = 0.198$ ). There was considerable collinearity between years of exposure and the linear and quadratic age variables which will have increased the standard error of years of exposure. However, the large sample size is likely to have compensated adequately for this effect.

In respect of the ability of Thermal Aesthesiometry and the Vibrotactile Threshold Tests to predict the diagnosis of Dupuytren's disease, we carried out a logistic regression, including age and age<sup>2</sup> as predictors along with the score in each case. The Thermal Aesthesiometry score was not a significant predictor – the OR associated with an increase of 1 unit in the Thermal Aesthesiometry score was 1.001 (95% CI 0.994, 1.009;  $P = 0.7$ ). Similarly, the effect of the Vibrotactile Threshold Tests score was not statistically significant – OR = 0.994, 95% CI 0.986, 1.003,  $P = 0.214$ . The Stockholm neurological staging was also used as a predictor in a separate analysis. This gave a similar, and non-significant, result (OR = 0.995, 95% CI 0.976, 1.015;  $P = 0.646$ ). The final analysis we carried out looked at the Stockholm vascular staging as a predictor of Dupuytren's disease. Again, there was not a statistically significant effect (OR = 0.019, 95% CI = 0.984, 1.055;  $P = 0.290$ ).

The results of the multifactorial model examining the effect of each variable controlling for the other variables were not substantively different from the reduced models and are shown in Table 4.

## DISCUSSION

The prevalence of Dupuytren's disease in the male adult community is difficult to assess. Gudmundsson et al. (2000) examined over 2000 randomly selected subjects in Iceland and reviewed previous studies of the prevalence of Dupuytren's disease. Four population studies (not involving hospital patients) have been performed and are shown in Table 5, with the relevant data from our miners' assessment shown in brackets in the right hand column for each study. The incidence of Dupuytren's disease (in all parameters measured) is considerably lower in the United Kingdom when compared with population studies in Norway, Sweden and Iceland. The prevalence of Dupuytren's disease identified in our miners' assessment is virtually identical to that found in the only previous United Kingdom population study (Early, 1962). Early's subjects were drawn from a locomotive works, an urban population and an old

**Table 4—The effect of age, diabetes, smoking, alcohol and exposure to vibration on the prevalence of Dupuytren's disease**

Risk factor	Number of people with risk factor	Number of people with risk factor and Dupuytren's disease	%	Reduced multifactorial model (with adjustment for age)				Full multifactorial model (with adjustment for all)				
				OR	Lower 95% CI	Upper 95% CI	P	OR	Lower 95% CI	Upper 95% CI	P	
<b>Age</b>												
Years				1.25	1.22	1.27	<0.001	1.236	1.211	1.262	<0.001	
Years <sup>2</sup>				0.999	0.999	1.00	<0.001	0.999	0.999	0.999	<0.001	
<b>Diabetes</b>												
No	96,392	7733	8.0	Reference category								
Yes	1188	202	17.0	1.52	1.3	1.77	<0.001	1.626	1.389	1.904	<0.001	
<b>Smoking</b>												
Never	35,948	2336	6.50	Reference category								
Ex-smoker	31,304	3147	10.05	1.10	1.04	1.17	0.001	1.013	1.138	1.315	0.016	
Light smoker	24,603	2051	8.34	1.27	1.19	1.36	<0.001	1.234	1.158	1.315	<0.001	
Heavy smoker	5725	401	7.00	1.31	1.17	1.47	<0.001	1.229	1.097	1.377	<0.001	
<b>Alcohol</b>												
Never	19,448	1700	8.74	Reference category								
Light	37,653	2862	7.60	1.09	1.02	1.16	0.012	1.031	1.173	1.448	0.004	
Moderate	26,717	2061	7.71	1.350	1.259	1.45	<0.001	1.350	1.259	1.448	<0.001	
Heavy	13,743	1312	9.55	1.59	1.47	1.72	<0.001	1.575	1.455	1.704	<0.001	
<b>Exposure to vibration</b>												
Years				1.002	0.998	1.005	0.198	0.999	1.002	1.005	0.232	

**Table 5—Previous studies describing the prevalence of Dupuytren's disease in males compared with the Miners Assessment Process**

<i>Author</i>	<i>Selected group</i>	<i>Diagnostic criteria</i>	<i>Number</i>	<i>Prevalence of Dupuytren's disease (Data from MAP)</i>
Early (1962)	Urban population Locomotive workers Old peoples home (United Kingdom)	Nodules and/or contractures	6979	18.1% of males over 75 (MAP 19.4% of males over 75)
Mikkelsen (1972)	Population sample (Norway)	Nodules and/or contractures	16,005	37% of males over 70 (MAP 18.3% of males over 70)
Bergenudd et al. (1993)	Population Sample (Sweden)	Nodules and/or contractures	319	10% of males aged 55 (MAP 4.6% of males aged 55)
Gudmundsson (2000)	Population sample (Iceland)	Nodules and/or contractures	2165	39% of males aged 60+ (MAP 15.4% of males aged 60+) 19.2% of males age 46–74 (MAP 9.8% of males aged 46–74)

people's home. The similar prevalence in the miners in our study and in Early's study would suggest that exposure to vibration does not provoke, or exacerbate, the development of Dupuytren's disease.

The rising prevalence of Dupuytren's disease with increasing age is well established (Hueston, 1960; Khan et al., 2004). Our paper confirms this finding and emphasises the need for controlling for age (both linearly and non-linearly) in any analysis of potential associations with Dupuytren's disease.

Khan et al. (2004) reviewed attendances to Primary Care in England and Wales with a first time diagnosis of Dupuytren's disease for a population of 500,000. The prevalence of Dupuytren's disease in manual workers was similar to non-manual workers up to the age of 59, in agreement with Mikkelsen (1978). However, in contrast to Mikkelsen's study, the post-retirement divergence produced a statistically significant higher prevalence in non-manual workers. Ross (1999), reviewing the available literature, considered that most authors believed there is no association between occupation and the risk of developing Dupuytren's disease. Early's (1962) population study identified an 18.1% prevalence of Dupuytren's disease in the United Kingdom in males over 75 years of age. Nineteen point four percent of the miners over 75 years of age in this study were noted to have Dupuytren's disease. These results would tend to support the view of Khan and his colleagues that Dupuytren's disease is not more common in those who are, or were, manual workers.

The prevalence of diabetes mellitus is known to be rising in the community. Gatling et al. (1998) reviewed a United Kingdom Community three times in 13 years through cross-sectional surveys. This crude prevalence in male population rose from 1.1 to 2.3 between 1983 and 1996. The main increase was noted to be in type II diabetics. Prevalence was noted to rise with age. The association between diabetes mellitus and Dupuytren's

disease is demonstrated in Table 4. Diabetes increases the odds of having Dupuytren's disease by approximately 50% (controlling for age).

Several authors have considered there to be an association between cigarette smoking and Dupuytren's disease (An et al., 1988). Burge et al. (1996) investigated the effect of smoking and alcohol on 222 Dupuytren's patients presenting for surgery, matched for age and sex with controls. All the patients had Dupuytren's disease of sufficient severity to justify surgical intervention. They concluded that smoking increases the risk of developing Dupuytren's contracture and contributes to its prevalence in alcoholics, who tend to smoke heavily. They observed a 2.8 OR for smoking and a 1.9 OR for alcohol. Our paper, assessing Dupuytren's disease with or without contracture, supports the view that smoking and alcohol consumption are associated with an increase in prevalence of Dupuytren's disease. For alcohol intake, a clear dose-response relationship was found. This is in agreement with the findings of An et al. (1988) and Burge et al. (1997). Higher consumption of both products is associated with an increased risk.

Hunter et al. (1944) described the clinical effects of the use of pneumatic tools in 286 men with a high incidence of Vibration White Finger. Only one case was noted to be suffering from Dupuytren's disease. Landrgrot et al. (1975) reviewed 807 workers exposed to vibration against 106 controls and found no statistical difference in the prevalence of Dupuytren's disease. Liss and Stock (1996) reviewed the previous literature and concluded that papers by Cocco et al. (1987), Bovensi et al. (1994) and Thomas and Clarke (1992) offered the best evidence of an association between Hand-Arm Vibration and Dupuytren's disease. Cocco and his co-authors (1987) reviewed workers exposed to vibration. Age matching was  $\pm 5$  years. One hundred and eighty cases with Dupuytren's contracture were identified from hospital files and 180 controls without Dupuytren's contracture

identified in a similar manner. A dose–response relationship between duration of vibration exposure and risk of Dupuytren's contracture was identified in the whole group and also in the sub-set who were miners. They considered there was a low, but definite, increase of risk of Dupuytren's contracture if exposed to vibration. However, the numbers in the study are small and poorly matched for age. Bovensi et al. (1994) investigated 570 quarry drillers exposed to vibration and 258 stone workers not exposed to vibration in a controlled cohort study. The OR for Dupuytren's contracture in the vibration exposed group was 2.6, but analysis of the case group did not show a greater risk with increasing life time dose of vibration. The number of the study population with a high exposure to vibration or with Vibration White Finger was low and Burge (2004) questioned how effectively age was controlled. Thomas and Clarke (1992) assessed 500 claimants for Vibration White Finger and found a Dupuytren's disease prevalence of 19.9% in vibration exposed workers compared to 10.7% in controls, (OR = 2.073). There were only a small number of miners in the study, the majority being steel or shipyard workers. Ten percent of miners had Dupuytren's disease. There was no correlation between the Taylor and Pelmear staging of Hand-Arm Vibration and the incidence of Dupuytren's disease. The control group was loosely defined and drawn from hospital patients who may have had a variety of morbidities which might have impacted on the prevalence of Dupuytren's disease within the group. The use of claimant's seeking compensation may also have created a selection bias.

The medical assessment process allowed us to identify the years of exposure to vibrating tools, but it was not considered practical to enquire into the specific tools, beyond those used by miners considered to expose them to the risks of Hand-Arm Vibration Syndrome. 'Anger time' (the time during the shift exposed to vibration) varies greatly throughout a miner's employment and it was not felt feasible to gain an accurate assessment of the overall vibration exposure in individual cases, beyond overall exposure in years in all forms of employment (Gerhaardsson et al., 2005). Nevertheless, exposure in years for such a large population of vibration-exposed workers does allow for an assessment of effect of vibration on the prevalence of Dupuytren's disease. Our study did not find a statistically significant difference in prevalence of Dupuytren's disease in those who had been exposed to vibration for longer periods (corrected for age).

Kischer and Speer (1984) observed microvascular occlusive changes in the tissues of the palm adjacent to Dupuytren's tissue and considered the Dupuytren's process to probably arise from low oxygen tension in the area stimulating collagen formation. The concept of poor tissue perfusion creating a fibrotic response accords with clinical experience. If there is an association between exposure to vibration and Dupuytren's

disease, the link might be through localised ischaemia. One of Kischer and Speer's six cases was a diabetic and another was an alcoholic; both conditions are known to have an increased incidence of Dupuytren's disease. However, the concept of local tissue ischaemia does not receive universal endorsement (Meyerding et al., 1941; MaCallum and Hueston, 1962).

Thermal Aesthesiometry and Vibrotactile Threshold Tests and sensory and vascular stagings did not correlate with the prevalence of Dupuytren's disease (corrected for age). Neurosensory and vascular impairment caused by vibration is considered to be dose related. If there is an association between the prevalence of Dupuytren's disease and the use of vibrating tools, a higher neurosensory and vascular staging would be expected to produce a higher prevalence of Dupuytren's disease. No increased prevalence was found after correcting for age.

There are inherent vulnerabilities to this study, which was not designed specifically for the investigation of Dupuytren's disease. The medical assessment process was created to provide compensation to a large number of miners and ex-miners in a consistent manner across 18 assessment centres. Doctors and technicians were trained and audited so that the assessment process was uniform across all centres. However, assessment of tool use and anger time with vibrating tools was not available. Current alcohol and cigarette consumption was self-rated by the claimants. No details were available on lifetime consumption, or the date of cessation of smoking for ex smokers. The data on diabetes mellitus did not identify duration or discriminate between types I and II, or Insulin dependency (all groups being included). Dupuytren's disease was diagnosed on the basis of nodules, bands or contracture, consistent with the experience of the examining doctors of this condition. More severe Dupuytren's disease with contracture was not identified separately from simple palmar thickening. All subjects were claimants seeking compensation and this may also have created a selection bias.

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F.D. Burke, Pulvertaft Hand Centre, Derbyshire Royal Infirmary, London Road, Derby DE1 2QY, UK. Tel.: +44 1332 290480; fax: +44 1332 291425.

E-mail: frank.burke@virgin.net

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