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Can Dupuytren's Contracture Be Work-Related?: Review of the Evidence

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Dupuytren's contracture (DC) is a disease of the palmar fascia resulting in thickening and contracture of fibrous bands on the palmar surface of the hands and fingers. For decades, a controversy has existed regarding whether acute traumatic injury or cumulative biomechanical work exposure can contribute to the development of this disorder. To address this controversy, this review considers the following questions: Is there evidence that DC is associated with 1) frequent or repetitive manual work; and 2) hand vibration? The published literature was searched for studies meeting the following criteria: 1) in English or having an English abstract; 2) controlled studies; 3) DC an identified health outcome studied; and 4) the study group exposed to repetitive or frequent manual work, vibration, or acute traumatic injury. Relevant non-English articles identified through English abstracts were translated. The validity of studies meeting the selection criteria was assessed using a series of questions adapted from those of Stock [1991: Am J Ind Med 19:87–107]. Studies that met a priori minimum levels of methodologic quality were taken into account to reach conclusions with respect to the above questions. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each study. Ten studies met the initial selection criteria. Of these, four studies met the criteria for methodologic quality, one addressing the relationship between manual work and DC, and three studies of vibration and DC. No controlled studies of acute trauma and DC were identified. Bennett [1982: Br J Ind Med 39:98–100] found the prevalence of DC at a British PVC bagging and packing plant in which workers were exposed to repetitive manual work to be 5.5 times that at a local plant without packing, and twice the expected prevalence in a U.K. working population previously studied by Early [1962: J Bone Joint Surg 44B:602–613]. DC was observed more frequently among vibration white finger claimants than controls by Thomas and Clarke [1992: J Soc Occup Med 42:155–158] (OR, 2.1; 95% CI, 1.1–3.9), and more frequently among vibration-exposed workers than controls by Bovenzi et al. [1994: Occup Environ Med 51:603–611] (OR, 2.6; 95% CI, 1.2–5.5). Cocco et al. [1987: Med Lav 78:386–392] found that a history of vibration exposure occurred more frequently among cases of DC than among controls (OR, 2.3; 95% CI, 1.5–4.4). The latter two studies presented some evidence of a dose-response relationship. There is good support for an association between vibration exposure and DC. © *1996 Wiley-Liss, Inc.*

KEY WORDS: Dupuytren's contracture, vibration, vibration white finger, manual work, traumatic hand injury, stonecarvers, quarry drillers, miners

INTRODUCTION

Dupuytren's contracture (DC) is a disease of the palmar fascia (aponeurosis) resulting in thickening and contracture of fibrous bands on the palmar surface of the hands and fingers, described in 1831 by Guillaume Dupuytren, a French surgeon, and later published in English [Dupuytren, 1834]. The principal clinical deformity is a slowly progres-

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TABLE I. Ratio of Men to Women in Those With Dupuytren's Contracture, by Age*

Age (years)	Men (%)	Women (%)	Ratio of men/women
20–24	0.19	0	∞
25–29	0.38	0	∞
30–34	0.23	0	∞
35–39	1.08	0	∞
40–44	2.50	0.29	8.4
45–49	4.95	0.95	5.2
50–54	9.95	1.73	5.8
55–59	14.42	2.28	6.1
60–64	21.87	3.74	5.8
65–69	27.01	8.00	3.4
70–74	36.67	13.45	2.7
75–79	33.66	16.48	2.0
80–84	32.99	17.78	1.3
85–89	30.77	25.00	1.2

*Data from Mikkelsen, 1990.

sive and irreversible flexion of the fingers [Glimcher and Peabody, 1990]. At its end stage, this shortening is termed a contracture. Other names for the condition include Dupuytren's disease, maladie de Dupuytren, and palmar fibromatosis.

Epidemiology

The condition is more frequent in males than females, and the prevalence increases with age, reaching 10–20% or higher among males, and 5% or higher among females in their 60s (Table I) [Mikkelsen, 1990; Anonymous, 1972, 1976], although the majority of cases found by Mikkelsen represented early stages of DC. The male/female ratio varies with age (Table I). There appears to be an increased incidence of DC among family members [Ling, 1963]. Geographical differences have been reported, with the prevalence thought to be higher in places such as Scandinavia, the Netherlands, United Kingdom, and Australia than in Mediterranean areas, Africa, and the Orient; however, Egawa et al. [1990] found DC to be just as prevalent in Japan. It is frequently bilateral; when unilateral, it has been more frequent in the right than left hand in some but not all series. Mikkelsen [1990] observed that there was usually a greater degree of contracture in the right than left hand. In some cases, changes similar to DC may be found in other parts of the body, including the feet (contracture plantar aponeurosis), the penis (Peyronie's disease), and knuckle changes on the extensor side of the hand (knuckle pads).

Some clinicians believe inherited predisposition is the only etiologic factor contributing to the development of this disorder [e.g., Hueston, 1987]. This hypothesis has never been proved and is not universally accepted. DC is also associated with diabetes mellitus, liver disease, and epilepsy [Hurst and Badalamente, 1990]. Rheumatoid arthritis may be found less frequently among those with DC than among those without [Arafa et al., 1984].

Diagnosis

The clinical picture includes nodules (which are usually central to the diagnosis), thickening or retraction of the skin, cords, and bands, and, finally, joint contracture. The ring finger has been most frequently affected in many series, followed by the little finger. The condition may be asymptomatic, even after contracture has developed, while others may complain of aching, tingling, or difficulty grasping objects; some eventually require surgery to the contracture for relief of symptoms or improved function [Viljanto, 1973; Simmons and Koris, 1992].

There is little confusion in recognizing advanced cases of DC, but the early signs challenge even the most experienced observer to distinguish between DC and the normal hand in which thick skin or prominent fascia are seen [McGrouther, 1990]. This feature is particularly important to bear in mind when interpreting the results of previous epidemiologic investigations or surgical series. Moreover, there are "no helpful ancillary diagnostic tests" [McGrouther, 1990] or "no confirmatory tests" [Simmons and Koris, 1992].

Reproducibility of diagnosis

Lennox et al. [1993] reported on the degree of clinical agreement between two orthopedic surgeons who independently examined 200 consecutive patients in geriatric wards in Aberdeen, Scotland. There was perfect agreement for observing flexion contractures (kappa 1.0), while for skin tethering, palmar nodules, and knuckle pads, there was good agreement (kappas of 0.8, 0.7, and 0.7, respectively).

Differential diagnosis

Conditions in the differential diagnosis [Viljanto, 1973; McGrouther, 1990] include congenital flexion deformity of fingers, flexion contractures in patients secondary to the hand being kept habitually closed (e.g., after organic disease of the central nervous system, strokes), scleroderma, joint afflictions like rheumatoid arthritis, tumors in the palm of the hand, or campylodactyly (permanent flexion of one or more fingers, usually little finger, present from childhood or adolescence).

Pathogenesis

Although the pathogenesis of DC remains obscure, cellular and biochemical changes have been identified. The cell that may be important in DC lesions has been termed a "myofibroblast" [Schürch et al., 1990] or "tractofibroblast" [Flint and Poole, 1990]. The biochemical changes include increased collagen content of palmar fascia [Glimcher and Peabody, 1990]; shifts in the types of collagen to a higher proportion of type III collagen [Bailey, 1990]; and an increase in total glycosaminoglycans with shifts from non-sulfated to sulfated glycosaminoglycans [Delbrück and Gurr, 1990].

An ongoing controversy among writers concerns the so-called "extrinsic" and "intrinsic" theories of the pathogenesis of DC. Skoog [1948, 1957, 1963, 1974] suggested that the strain to which certain elements of the aponeurosis were subjected was essential in the pathogenesis of DC, and that the disease originated in fibrillar ruptures and microhemorrhages within the aponeurosis. This theory has been termed the "intrinsic" hypothesis of longitudinal fiber rupture and is considered to be support for the notion that microtrauma in occupation plays a role in the condition. Microvascular changes (occlusions) have been observed in DC [Kischer and Speer, 1984].

In contrast, Hueston [1985, 1987], and Hueston and Seyfer [1991] disagreed, arguing that Skoog's theory cannot explain the onset without local injury apart from disuse and local edema, and the common recurrence of identical tissue after removal of the involved aponeurosis. His "extrinsic" hypothesis was based on observations that nodules develop within the subcutaneous space on the anterior aspect of the palmar aponeurosis. Flint and McGrouther [1990] pointed out that the concept that Dupuytren's nodular lesions arise from intrafascial rupture "has been repeatedly criticized [by Hueston] but without any firm scientific rebuttal."

Finally, recent studies examining lymphocytes have suggested the possibility that DC is a T-cell-mediated autoimmune disorder [Baird et al., 1993]. A successful response to topical corticosteroids reported by Shelley and Shelley [1993] suggested that the local immunological inflammatory change triggered by DC can be suppressed.

Relationship to Work

For decades, a controversy has existed regarding whether acute traumatic injury or cumulative biomechanical work exposures can contribute to the development of this disorder. From an historical perspective, Smith and Masters [1939] and Bell and Furness [1977] noted that in 1912, a government committee in the United Kingdom examined the possibility of a relationship between trauma and DC and found that there was no conclusive relationship.

Concern over compensation has flavored some writings, as Flint and McGrouther explained [1990, p. 285]:

> It is our belief that there has been some resistance to the acknowledgement of the role of intrafibrillar rupture in the pathogenesis of the Dupuytren's process for fear that if a causal relationship between trauma and [DC] was established and recognized, there would be a plethora of legal claims attempting to prove that [DC] has been caused by damage to the hands at work.

Single injury and Dupuytren's contracture

Much has been written about whether DC might arise as a complication of hand injury, that is, those who suffer from DC are apt to attribute the disease to a single accident [Smith and Masters, 1939]. There are case reports of DC that followed in time after a single hand injury such as penetrating wounds, crush injuries, and fractures [e.g., Hueston, 1962, 1963, 1968]. Hueston [1968] presented data showing that among a series of DC cases, there was a much higher proportion associated with a hand injury in the younger age groups compared with that among older cases.

In general, there has been more acceptance by clinicians and compensation boards of the association of DC with single injury than with chronic manual work. However, caution is needed in interpreting previous reports because the impressions are anecdotal. To our knowledge, no epidemiologic investigations have been conducted to study this association. The microscopic similarities between DC and wound healing, and the obvious stimulus to the fibroblasts after trauma do, however, support the case for biologic plausibility.

There are data from a complementary approach, involving the past history of single injury among those DC cases *coming to surgery* [McFarlane et al, 1990a; McFarlane, 1991]. In their survey of 1,150 surgical cases of DC [McFarlane et al, 1990a], the investigators asked a question about a history of a single injury associated with the onset of DC. The findings have been summarized by McFarlane and Shum [1990]. Within this surgical series, variables that were significantly associated with the patient relating "a single injury to the onset of disease" included male gender, age at onset if male less than 45 years, manual labor, unilateral disease, and one ray involved. However, those cases coming to surgery may not be representative of all DC cases, and are more likely to be of greater severity, with contractures.

Study Objectives

To address the above controversy about the relationship of DC to work, this review considers the following ques-

tions: Is there evidence that DC is associated with 1) frequent or repetitive manual work and mechanical rubbing; and 2) hand vibration.

METHODS FOR LITERATURE REVIEW

Search Methods

The following strategies and sources were used to identify as many relevant studies and reviews as possible:

1. a Medline computer search, conducted in October 1993, with the following key words for search: Dupuytren's contracture and acute injury and cumulative trauma and occupation. Two previous searches (with key words Dupuytren's contracture and epidemiology) conducted for the Industrial Disease Standards Panel in Ontario were also examined
2. NIOSHTIC
3. occupational medicine texts and journals
4. books on Dupuytren's contracture [Hueston, 1963; Hueston and Tubiana, 1974, 1985; McFarlane et al., 1990b]
5. references in review articles and books
6. Index Medicus, searched manually for 1990–1993, and monthly supplements through October 1994.

Consideration of Original Articles

Identification of relevant studies

Original studies were chosen for more detailed review if their titles (and/or abstracts if available) met the following criteria: 1) published in English or having an English summary of a non-English study (if the article appeared relevant, a translation was obtained); 2) DC an outcome identified (studies of cases of DC having operations were not included); 3) conducted in one or more working populations or if population-based, then comparisons made of manual vs. non-manual work; 4) the group of interest exposed to manual or repetitive work, or vibration; 5) controlled studies: study design was case-control, cross-sectional, or cohort studies, with comparison group (case reports and case series without controls were not included).

Assessment of validity of studies

Most of the studies identified were cross-sectional in design. The quality of the studies examining the association of DC and manual work/vibration was assessed independently by both authors using a validity assessment questionnaire (provided in Appendix A) that included the seven criteria considered by Stock [1991]: absence of selection bias, absence of nonrespondent bias, comparability of study and control groups, accounting for confounders, validity of exposure measures, validity of outcome measures, and blinding of assessors. The interobserver agreement of the ranking was calculated using the kappa statistic [Sackett et al., 1985]. Differences were resolved by consensus. Information obtained by correspondence with an author has been indicated.

The three criteria judged to pose the greatest threats to validity were comparability of the groups, and validity of exposure and outcome measures (items 3, 5, and 6 in Appendix A). Major flaws (i.e., score of 1) in any of these areas were considered to compromise the validity of a study seriously. Only studies scoring 2 or more for these three criteria were considered acceptable to address the study questions further. Causality was assessed using criteria adapted from Hill [1965] [e.g., Sackett et al., 1985; Rothman, 1986], particularly strength of the association, temporality, consistency, and demonstration of a dose-response relationship.

Statistical Methods

Odds ratios and 95% confidence intervals for each study were calculated, if not provided, using True Epistat [Epistat Services, 1989]. Correlations were computed with PC-SAS. We did not consider there to be sufficient similarity among studies to justify aggregating the results.

RESULTS

Studies Selected

From the potentially relevant studies, seven English language studies (eight papers) were identified that met the above criteria. Six potentially relevant studies in other languages were identified and were translated; three met the criteria. Case and surgical series and other reports not meeting the criteria are listed in Appendix B. Table II outlines the main features of the five studies that considered manual work, and Table III gives the features of the five that addressed vibration. Table IV summarizes the study results.

Validity Assessment of Studies

The validity assessment of the study methodology is presented in Table V. The kappa for interobserver rating was 0.7, indicating moderate to good agreement. The quality (ranking) of the studies ranged from poor (8) to good (18), with median rank about 11. The greatest weaknesses were the lack of blinding of examiners and inadequate exposure measures. When one restricts consideration to studies with scores of 2 or more on the three criteria of comparability of groups, valid exposure measures, and valid outcome measure, the studies remaining include those by

TABLE II. Summary of Studies on Manual Work and Dupuytren's Contracture*

Feature/ study	Herzog	Early	Hueston	Mikkelsen	Bennett
Country (year)	U.K. (1951)	U.K. (1962)	Australia (1960)	Norway (1978, 1990)	U.K. (1982)
Design	Cross-sectional	Cross-sectional	Cross-sectional	Population-based survey	Cross-sectional
Study subjects	503 steel workers > 40 years old 451 miners > 40 years old	4,454 male manual workers at locomotive works (4,375 < 65 years old)	530 male brewery workers	477 males, 6 females in heavy work; 2,304 males, 4,710 females in medium work; 2,285 males, 707 females in light work	216 workers at PVC bagging and packing plant
Control subjects	480 clerks > 40 years old	427 male office workers at same locomotive works (426 < 65 years old)	550 male office workers	1,805 males, 1,104 females in non-manual work	1) 84 workers at another plant with no bagging or packing; 2) also compared with prevalence among male workers (clerical and manual) from Early [1962]
Exclusions	Not stated	Not stated	Not stated	Response rate to survey 71% for males, 82.4% for females; occupation obtained only for 13,415 of 15,950 residents examined.	No exclusions at study plant Not stated for other plant
Outcome	Presence of DC; no grading system	Presence of DC; system of staging reported	DC on examination of hands: thickening in palm either as nodule or plaque/band accepted	Examination of town inhabitants for presence of DC based on finding of nodules	DC on inspection of hands; used scheme from Early [1962]
Blinding of examiners/ assessors	Not stated	Not stated	Not stated	Not stated	Not stated
Exposure	Manual vs. non-manual (clerks)	Manual vs. office workers (job title)	Presumed manual vs. office	Type of work: "heavy," "medium," "light," "non-manual"	Bagging and packing vs. 1) no bagging and packing; 2) manual and clerical workers at locomotive works [Early, 1962] Asked about tools and chemicals handled through career
Confounders measured	Age restriction; no stratification	Age	Age	Gender	Age, gender Asked about family history, past illness, injuries, alcohol
Analysis	In original: %, OR[a]	In original: % (relative frequency), M-H X^2, OR[a]	In original: %, M-H X^2, OR[a]	In original: %, M-H X^2, OR adjusted for gender[a]	% and indirect standardization (morbidity ratio)
Conclusion	"Slight differences in incidence between clerks and workmen is of no significance"	Prevalence of DC no different in manual vs. office	DC prevalence no higher in brewery workers	Prevalence of DC increased with increasing heaviness of work	Prevalence of DC increased at bagging and packing plant

*DC, Dupuytren's contracture; M-H X^2, Mantel-Haenszel chi-square; OR, odds ratio
[a]By authors.

Bennett [1982], Cocco et al. [1987], Thomas and Clarke [1992], and Bovenzi et al. [1994] (indicated by asterisk in Table IV).

Study Findings (Table IV)

Manual work

Bennett [1982], in the only study of manual work without major flaws, observed a standardized morbidity ratio of 1.96 among bagging and packing plant workers compared with the expected age-adjusted prevalence found previously by Early [1962], and an odds ratio (OR) of 5.5 compared with a local plant without bagging and packing. Of the remaining studies, considered to have major flaws, two found no association with DC [Hueston, 1960; Early, 1962], and one found a weak non-significant association [Herzog, 1951]. From the data of Mikkelsen [1990], gender-adjusted Mantel-Haenszel ORs of 3.1, 2.7, and 2.0 were computed for heavy, medium, and light work, respectively, compared with non-manual work.

Vibration

Three studies of DC and vibration met the validity criteria. Thomas and Clarke [1992] found that DC was observed 2.1 times as frequently among vibration-exposed claimants with vibration white finger (VWF) compared with subjects being admitted to hospital for surgery (Table IV). Cocco et al. (1987) reported that a history of exposure to vibration at work was found more frequently among cases of DC compared with controls without DC (OR, 2.3; 95% CI, 1.5–4.4). This effect was unchanged when adjusted for alcohol consumption and the presence of peripheral vascular abnormalities by photoplethysmography. There was a dose-response relationship with increasing du-

TABLE III. Summary of Studies on Vibration and Dupuytren's Contracture*

Feature/ study	Landgrot	Patri	Cocco	Thomas and Clarke	Bovenzi
Country (year)	Czechoslovakia (1975)	France (1982)	Italy (1987)	U.K. (1992)	Italy (1994)
Design	Cross-sectional	Cross-sectional	Case-control	Cross-sectional	Population-based cross-sectional survey
Study subjects	807 workers exposed to vibration (791 < 65 years old)	107 lumberjacks exposed to vibration	Cases: 180 cases of DC identified from 14,557 clinical files of Instituto di Medicina del Lavoro of Cagliari, 1970–1985	500 claimants considered to have VWF assessed 1988–1990 (311 aged 50–85)	570 quarry drillers and stonecarvers exposed to vibration
Control subjects	444 maintenance workers and clerical workers	115 manual workers not using vibrating devices	Controls: 180 subjects from same files without evidence of DC, matched with a case by sex, age (± 5 years), and hospitalization (± 7 days)	150 consecutive males aged 50–85 admitted to Middlesborough Hospital for elective or emergency treatment to surgical ward; none had VWF symptoms	258 stone workers (manual polishers and machine operators) not exposed to vibration
Exclusions	Not stated	Not stated	All cases of contracture included	None stated	None (all participated); random sampling of controls
Outcome	Presence of DC; grading not stated	Examination of hands (no details or grading system	Cases defined by presence of definite contracture (initial isolated palmar fascia thickening or knuckle pads not considered)	Exposed: "all stages of DC from nodule to examined for presence of DC following admission	DC on examination of [illegible] no grading stated (on grading scheme used)
Blinding of examiners/ assessors	Not stated	Not stated	(Blinding to case status during determination of exposure): not stated	No	Not stated (on correspondence, indicated that examiners were blinded to exposure status)
Exposure	Vibration exposed (pneumatic tool operators, forestry, miners, stonecutters, grinders) vs. controls (maintenance workers, machine shop, clerical workers)	Vibration exposure (66 of 107 had VWF) vs. controls ("manual" workers not using vibrating devices, < 50 hours/year)	Occupational history used to establish exposure to vibration, its duration, and tools used during work activity (exposed defined as miners, hammer-drill operators, stone cutters, construction workers, saw-mill workers, sawing-machine, milling, or grinding-machine operators); photoplethysmography of fingers performed to investigate angiopathy	Vibration exposure vs. controls (102 heavy manual labor, 29 clerks and teachers, 19 semi-skilled and unskilled occupations)	Quarry drillers used rock breakers and drills; stonecarvers: some used only rotary tools (angle grinders) and others used both rotary and percussive tools (angle grinders and light stone hammers). Vibration measured in terms of hr/d, d/yr, and total years. Vibration measured on handles of representative sample of tools according to ISO 5349 under actual conditions by accelerometers to yield lifetime vibration dose
Confounders measured	Age	No age stratification; controls recruited so average age similar	Age and sex matching, alcohol	Age restriction	Age, smoking, alcohol consumption, upper limb injuries, leisure activities, other diseases
Analysis	In original: %, OR[a]	In original: %, OR[a]	OR, X^2 for trend	In original: %, X^2 OR[a]	%, OR with adjustment for age, smoking, alcohol consumption, and upper limb injuries
Conclusion	"No substantial difference in incidence of DC between various occupations"	Frequency of stage I DC identical among lumberjacks and manual workers; DC similar among lumberjacks with and without VWF	Statistically significant increase in risk of DC in workers occupationally exposed to vibration; a dose-response relationship between duration of employment in jobs with use of vibrating tools and risk of DC observed. Same result observed considering only miners	Prevalence of DC increased in vibration-exposed (VWF) claimants	Prevalence of DC was higher in quarry drillers (11.0%); stonecarvers using only rotary drills (6.4%); and stonecarvers using both rotary and percussive tools (12.2%) than in controls (3.5%). Prevalence and OR increased with increasing lifetime vibration dose category. However, trend statistic was not significant

*DC, Dupuytren's contracture; OR, odds ratio; VWF, vibration white finger.
[a]By authors.

ration (years) of exposure to vibration (Table IV). A similar result was observed if only miners were analyzed (OR, 2.1; 95% CI, 1.3–3.4). Bovenzi et al. [1994] reported that, compared with control stone workers in Italy who performed manual work only, DC was observed more frequently among quarry workers (OR, 2.6; 95% CI, 1.1–6.2), stonecarvers who used rotary tools only (OR, 1.9; 95% CI, 0.7–4.6), and stonecarvers who used rotary and percussive tools

TABLE IV. Summary of Results of Studies of Manual Work/Vibration and Dupuytren's Contracture*

Study	Comparison for DC	Odds ratio	95% CI
Studies of manual exposure			
Bennet [1982][a]	Bagging plant vs:		
	Non-bagging plant	5.5	0.8–36.7
	Office and manual locomotive workers	1.98	
	[Early, 1962]	(observed, 16; expected, 8.08)	1.1–3.2
Early [1962]	Manual vs. clerical	0.98	0.6–1.7
Mikkelsen [1978, 1990]	Males		
	Heavy vs. non-manual	3.1	2.2–4.3
	Medium vs. non-manual	2.3	1.8–2.9
	Light vs. non-manual	1.9	1.5–2.4
	Females		
	Heavy vs. non-manual	21.9	0.9–230
	Medium vs. non-manual	5.4	2.8–10.9
	Light vs. non-manual	3.2	1.4–7.3
	M-H OR adjusted for gender		
	Heavy vs. non-manual	3.1	2.2–4.4
	Medium vs. non-manual	2.7	2.1–3.3
	Light vs. non-manual	2.0	1.6–2.5
Hueston [1960]	Brewery vs. office	0.9	0.6–1.4
Herzog [1951]	Steelworkers vs. clerical	1.2	0.6–2.3
	Miners vs. clerical	1.3	0.6–2.5
Studies of vibration			
Bovenzi et al. [1994][a]	Quarry drillers vs. controls	2.6	1.1–6.2
	Stonecarvers vs. controls:		
	Users of rotary tools only	1.9	0.7–4.6
	Users of rotary and percussive tools	3.2	1.4–7.2
Thomas and Clarke [1992][a]	Vibration-exposed (VWF) vs hospital admissions	2.1	1.1–3.9
Cocco et al. [1987][a]	Vibration exposure (DC cases vs. controls)	2.3	1.5–4.4
	< 10 yr exposure	1.7	0.9–3.4
	11–20 yr exposure	2.4	1.3–4.2
	> 21 yr exposure	3.0[b]	1.3–6.7
Patri et al. [1982]	Lumberjacks vs. controls (machine shop)	0.9	0.5–1.8
Landgrot et al. [1975]	Vibration-exposed vs. controls	1.2	0.8–2.0

*DC, Dupuytren's contracture; CI, confidence interval; M-H OR, Mantel-Haenszel odds ratio; VWF, vibration white finger.
[a]Studies meeting validity criteria.
[b]Chi-square for trend $p < 0.05$.

(OR, 3.2; 95% CI, 1.4–7.2). Two other articles, which did not meet the criteria for final inclusion [Landgrot et al., 1975; Patri et al., 1982], found no association between DC and vibration exposure, but the control groups consisted largely of "manual" workers.

Causality

In all the investigations meeting the validity criteria, a positive association was demonstrated between manual work/vibration and DC. Are these associations causal? Considering criteria such as those suggested by Sackett et al. [1985] or Rothman [1986], the strength of the association is moderate to strong in one study of manual work and three of vibration exposure (ORs ranging from 2 to 3). For no study could temporality be determined with certainty, although Cocco et al. [1987] did look at duration of exposure. These investigators also demonstrated a dose-response relationship. Although Bovenzi et al. [1994] presented data showing that the prevalence of DC increased with increasing category of lifetime vibration dose, the conservative trend statistic used by the authors was not significant. A conventional chi-square test for trend was highly significant ($p < 0.0001$ among the exposed). However, given that the

TABLE V. Validity Assessment Results of Studies of Manual Work/Vibration and Dupuytren's Contracture

	Herzog [1951]	Hueston [1960]	Early [1962]	Mikkelsen [1978]	Bennett [1982]	Thomas and Clarke [1992]	Landgrot et al. [1975]	Patri et al. [1982]	Cocco et al. [1987]	Bovenzi et al. [1994]
Population										
Selection bias	1	1	1	2	1	2	1	1	2	2
Nonrespondent bias	1	1	1	2	2	3	1	1	2	2
Comparable groups[a]	2	2	2.5	1	2.5	2	2	2	2.5	3
Exposure										
Confounders	1	1	1	1	2	1	1	2	2	3
Valid exposure measures[a]	1	1	1	1	2	2	1	2	2	2
Outcome										
Valid outcome measures[a]	1	2	3	3	3	2	2	1	2	3[b]
Blinding of examiners	1	1	1	1	1	1	1	1	1	3[b]
Total (out of 21)	8	9	10.5	11	13.5	13	9	10	13.5	18

[a]Criteria considered most likely to compromise validity (if score of 1).
[b]Based on correspondence with author

study was cross-sectional in design, one cannot tell if the assigned current cumulative dose category is the one at which DC arose; thus, the suggestion of a trend could be overestimated. In summary, there is support for the hypothesis that vibration exposure is a risk factor for DC, and weaker evidence for such a relationship for manual work.

DISCUSSION

This review found one investigation of acceptable quality that addressed the relationship between DC and manual work, and three studying the relationship between DC and vibration. All four studies showed a positive association, with at least a doubling of risk.

Most of the studies identified were cross-sectional, a design that is inherently limited for a number of reasons. For example, there may be "survivor bias" (those who have developed disease may have left the work force, leading to an underestimation of risk among those presently employed). Second, prevalence data, when exposure and disease are obtained at the same time, cannot easily be used to determine cause and effect relationships. The temporal sequence of exposure and the development of disease is not established.

In addition, some of the studies available, as noted above, are limited in quality, suffering from two major weaknesses: rarely were examiners of hands for the presence of DC (in cross-sectional studies) blinded to exposure status, or were assessors of exposure (in the case-control study) blinded to case status. Few studies provided quantitative description of *exposure* in these studies, with respect to force, frequency, and vibration (merely job title), except that by Bovenzi et al. [1994] and perhaps Cocco et al. [1987].

The quality of the studies (as estimated by the rating) appeared to improve over time (Spearman rank correlation coefficient, $r_s = 0.83$; $n = 10$; $p < 0.01$), as did the strength of the association (OR) ($r_s = 0.74$; $p = 0.01$). In turn, the ORs were correlated with the rating ($r_s = 0.68$; $p = 0.03$) suggesting that the better the study quality, the stronger the association observed.

On reviewing the early literature about DC, a number of serious problems became apparent, which should be borne in mind. These include possible difficulty in diagnosing the condition (the prevalence observed may vary with what criteria are used); the fact that studies did not always stratify by or separate genders or age groups [as noted by Thomas and Clarke, 1992]; and that there have been problems with terminology, for example, inconsistent use of the term "injury" with failure to distinguish between "injury" and "trauma," the latter used interchangeably with "manual labor" and "repetitive trauma."

Manual Work

With only one study of adequate methodologic quality, the relationship of DC to manual work is uncertain. The study by Bennett [1982], which ranked highest in quality among those addressing manual work, showed approximately a doubling of observed cases, compared with the expected prevalence. The association cannot yet be considered causal and needs to be confirmed elsewhere. Better exposure data are needed to test the hypothesis that exposure to mechanical rubbing from hand tools, controlling for vibration, leads to DC.

Vibration

There is evidence supporting this association from three studies of adequate quality [Thomas and Clarke, 1992; Cocco et al., 1987; Bovenzi et al., 1994]. The findings by Bovenzi et al. [1994] showed consistent increased relative risks, addressed confounding factors in multivariate models, and demonstrated some evidence of increasing prevalence with cumulative lifetime vibration categories. The data reported by Thomas and Clarke [1992], however, should be interpreted with caution for two reasons: first, the study group examined by the authors was not, strictly speaking, one with vibration exposure per se but rather a subgroup of the vibration-exposed population that developed VWF. Those developing VWF may differ from other vibration-exposed subjects (and controls) in some way that may also be associated with the development of DC. Second, because the control group in this study was drawn from patients being admitted to hospital, their location was no doubt different than that for the VWF claimants. Thus, lack of blinding of examiners in this study may have been more likely than in other studies. On the other hand, the inclusion of "manual" workers among the control subjects in this report and those of Landgrot et al. [1975] and Patri et al. [1982] may have tended to dilute or mask the association.

The consistent findings in these three studies are supported by the report by Roberts [1981] of two men who developed DC after 4.5–5 years of vibration exposure on a grinding wheel while removing deeply imprinted lettering from metal starter yokes; none of six other, lesser exposed employees exposed for periods from 2 months to 5 years showed evidence of DC.

CONCLUSIONS

There is good support for an association between vibration exposure and DC, and the studies we examined met a number of the criteria for causality; there is weaker evidence for such an association with manual work. Additional studies of better quality, including better characterization of exposure, are required to explore further the association of DC with manual work and with single injury to refute or provide evidence to support these hypotheses.

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APPENDIX A
CRITERIA USED TO ASSESS VALIDITY OF MANUAL WORK/VIBRATION[1]

Population

1. Was potential for bias in selection of subjects for study group or controls avoided?
   - 3 Minimal or no flaws: all potential workers included; survivor bias (healthy worker effect) avoided
   - 2 Minor flaws: volunteer bias possible; survivor bias possible (e.g., cross-sectional study design)
   - 1 Major flaws: selection method not reported
2. Was nonrespondent bias avoided?
   - 3 Minimal or no flaws: 90% or more responded
   - 2 Minor flaws: response rate 75–89%; 90% or more in one group but not reported in other
   - 1 Major flaws: response rate not reported; response rate < 75%
3. Were controls and study group comparable with respect to age, sex, socioeconomic status, ethnic origin, family history of Dupuytren's contracture, previous hand injury, and conditions associated with Dupuytren's contracture (such as diabetes, epilepsy, alcoholism/cirrhosis)?

1. Adapted from Stock [1991]. Numbers under each item (3, 2, 1) = score.

3 Minimal flaws: groups comparable on all the above; if not, items were controlled for in analysis
2.5 Minor flaws: age and gender measured, and controlled for in analysis, or three or more age strata
2 Significant flaws: age and sex measured but differences not properly controlled for in analysis (e.g., age restriction; only two strata; or those greater than age 60 excluded)
1 Major flaws: personal confounders not reported or not measured

Exposure

4. Were the following confounding exposures controlled for in both control and study groups: other exposures at work or non-workplace stressors such as hobbies involving manual activities or vibration?
   3 Minimal flaws: all relevant exposures measured and controlled for in analysis
   2 Minor flaws: some or all confounders measured but differences not controlled for in analysis (e.g., may have asked about past jobs, other chemicals)
   1 Major flaws: exposure confounders not reported or not measured (job title only)
5. Were direct and valid measures for exposure used such as years of manual labor, description of tools used, job titles used in ranking or classification, weights lifted or forces required, measures of repetition (frequency, duration of work cycle, number of work items)?
   3 Minimal flaws: appropriate measures of exposure used: applied to controls and study group; measures of exposure applied to each individual subject/control
   2 Minor flaws: unable to measure exposure in controls with same method as study group but exposure highly unlikely (e.g., asked about tools used);
   1 Major flaws: exposure measures not reported or not measured

Outcome

6. Were direct and valid criteria used to measure outcome?
   3 Minimal flaws: relevant diagnostic entity (Dupuytren's contracture is only outcome of interest here); grading or staging system used is reported and referenced
   2 Minor flaws: relevant diagnostic entity (Dupuytren's contracture is only outcome of interest); grading or staging system mentioned but grading or stages not given or referenced
   1 Major flaws: outcome criteria not reported; no grading or staging system mentioned
7. Were the examiners of subjects' hands (in cross-sectional studies) blind to "exposure status" or were assessors of exposure (in case-control studies) blind to case-control status?
   3 Minimal flaws: complete blinding of examiners/assessors
   1 Major flaws: blinding not done or not reported

APPENDIX B

Articles Obtained and Considered That Did Not Meet Criteria

Case series of Dupuytren's contracture

Bell RC, Furness JA (1977): A study of the effect of recurrent trauma on the development of Dupuytren's contracture. Br J Plast Surg 30:149–150.

de Larrard J, Hitier CP, Dervilleé, Doignon J, Robert M (1969): The role of traumatism in the etiology of Dupuytren's disease. Bordeaux 721–724 (English translation).

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Case series of Dupuytren's contracture operated upon

Marx J, Schunk W (1982): On the role of occupational and dispositional factors in the origination of Dupuytren's contracture. Beitr Orthop Traumatol 29:477–483.

McFarlane RM, Botz JS, Cheung H (1990): Epidemiology of surgical patients. In McFarlane RM, McGrouther DA, Flint MH (eds): "Dupuytren's Disease: Biology and Treatment." New York: Churchill Livingstone, pp 201–238.

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Occupational group without comparison groups

de la Caffinière JY, Wagner R, Etscheid J, Metzger F (1983): Manual work and Dupuytren's disease: Result of a computerized survey made among iron workers. Ann Chir Main 2:66–72 (English translation; no comparison of prevalence between groups given).

Pardi F, Ambrosino N, Bachini P, Loi AM, Paggiaro PL (1982): Clinical and laboratory evaluation in vibration syndrome: A study on fifty subjects. G Ital Med Lav 4:145–149 (English translation).

Other

Bergenudd H, Lindgärde F, Nilsson BE (1993): Prevalence of Dupuytren's contracture and its correlation with degenerative changes of the hands and feet with criteria of general health. J Hand Surg 18B:254–257. (Population-based health survey in Sweden. Authors indicated that there was no difference in occupation work load between subjects with and those without Dupuytren's contracture but presented no data).