

Incidence and determinants of carpal tunnel decompression surgery in type 2 diabetes:  
The Fremantle Diabetes Study

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## ABSTRACT

To examine the incidence and predictors of carpal tunnel decompression (CTD) in community-based patients with type 2 diabetes, we studied 1,284 type 2 participants (mean±SD age 64.1±6.1 years, 49.1% males) in the longitudinal observational Fremantle Diabetes Study (FDS) who had no history of CTD. Sixty-seven (5.8%) had a first CTD during 12,109 (mean 9.4±3.7) years of follow-up, an incidence of 5.5/1,000 patient-years. This was at least 4.2 times the incidence in the general population ( $P < 0.001$ ). In Cox proportional hazards analysis, significant independent determinants of first-ever CTD were higher body mass index, taking lipid-lowering medication and being in a stable relationship ( $P \leq 0.021$ ). The crude incidence of first CTD is increased in type 2 diabetes and is associated with obesity and socio-demographic/treatment factors that could indicate treatment-seeking behaviour that includes CTD in symptomatic patients.

Carpal tunnel syndrome (CTS) is the commonest entrapment neuropathy complicating diabetes (1), with an incidence several-fold that in the general population (1-3). Based on clinical/electrophysiological assessment (4), one-third of type 2 patients have CTS and one-sixth of these report symptoms. Conventional treatments comprise splinting, diuretics and corticosteroid injections, and carpal tunnel decompression (CTD) if conservative measures fail (2). Open and endoscopic CTD have equivalent outcomes (5), with 75% of cases cured or minimally symptomatic (6) regardless of diabetes status (7). There are, however, few epidemiologic data relating to CTD in diabetes. In the general population, 0.4-1.4 decompressions are conducted per 1,000 person-years (3) but the relative CTS prevalence suggests a higher rate in diabetes. Our aim was, therefore, to determine the incidence and predictors of CTD in well-characterized type 2 patients.

**RESEARCH DESIGN AND METHODS**– The Fremantle Diabetes Study (FDS) was a longitudinal observational study in a community of 120,097 people (8). Of 2,258 diabetic patients identified between 1993 and 1996, 1,426 (63%) were recruited and 1,294 had type 2 diabetes. The FDS protocol was approved by the Fremantle Hospital Human Rights Committee. All subjects gave informed consent before participation. Baseline and annual reviews comprised a detailed questionnaire, physical examination and biochemical tests on fasting blood/urine samples (8). Complications were identified using standard criteria (9).

All deaths and public/private hospitalizations in Western Australia (WA) are recorded in the WA Data Linkage System (WADLS) (10). The Confidentiality of Health Information Committee approved linkage of the WADLS and FDS databases. All hospitalizations for open/endoscopic CTD from 1993 until end-June 2006 were identified using International

Classification of Diseases 9-CM codes 04.43/04.45 and 10-AM codes 39331-01/39331-00 for type 2 FDS patients and the WA population. Correct coding was confirmed by chart review in a sample of 28 FDS patients. The incidence of first CTD was determined i) in FDS patients by dividing the number by duration of follow-up to CTD or death/end-June 2006, and ii) in the WA population from CTD hospitalizations between January 1993 and June 2006 and corresponding annual population figures. Kaplan-Meier plots of CTD-free survival by sex were compared by log-rank test. Cox proportional hazards modeling with forward conditional variable entry ( $P < 0.05$ ) and removal ( $P > 0.10$ ) was used to determine independent predictors of first CTD.

**RESULTS**– There were 1,284 type 2 FDS subjects without a self-reported/WADLS-documented CTD at baseline. Sixty-seven (5.8%) had a first CTD during 12,109 (mean  $9.4 \pm 3.7$ ) years, an incidence of 5.5/1,000 patient-years. Men and women had a similar incidence (5.8 vs 5.3/1,000 patient-years;  $P = 0.74$ ). Eighteen patients (26.9%) had at least two CTDs during follow-up, representing re-operation or decompression in the opposite hand. CTD was performed in a private facility in 76.1% of cases.

In the WA population, 32,836 people had a CTD during 25,226,010 person-years, or 1.30/1000 person-years (95% confidence interval (CI), 1.29-1.32). The CTD incidence in the FDS subgroup was, therefore, 4.2 times higher ( $P < 0.001$ ), but this is a conservative relative rate since the general population incidence does not exclude further CTDs in the same patient.

Baseline univariate determinants of incident first CTD are shown in the Table. In Cox modeling, independent associates were higher body mass index (BMI) (hazard ratio [95% CI]; 1.05 [1.01-1.09]), taking lipid-lowering therapy (2.32 [1.30-4.13]) and being married/in a *de facto* relationship (2.04 (1.11-3.74);  $P \leq 0.021$ ).

CONCLUSIONS– The crude incidence of first CTD in our type 2 patients is between 4 and 14 times published general population figures (3) and at least 4.2 times that in the WA population. This difference parallels the three-fold increased risk of CTS in type 2 diabetes (11,12). Consistent with a general population study that identified obesity as a strong associate of CTD (13), a 1 kg/m<sup>2</sup> increase in baseline BMI increased the likelihood of CTD in our patients by 5%. Unlike other studies of CTS determinants in general-population (1,2,14,15) and diabetes-specific (4,12,16-19) studies, we did not find that baseline age, gender, diabetes duration, arthritis, microangiopathy, smoking or thyroid disease predicted CTD.

Our data suggest that socio-demographic factors are important determinants of CTD in type 2 diabetes. The relationship with marital status could reflect a partner's influence on the decision to pursue CTD. In addition, the ability to pay for a private operation (given long public waiting lists) would be greater with multiple income sources, consistent with the univariate inverse association between household income and CTD in our data. However, the apparent importance of socio-demographic factors compared with recognized CTS associates in diabetes (4,12,16-19) might also indicate that variables such as older age and vascular complications are contraindications to surgery.

Since indications for lipid-lowering therapy in diabetes were less inclusive during FDS recruitment than subsequently (20), baseline use of these agents could have been a surrogate for general treatment-seeking behaviour including CTD. Uptake of lipid-lowering therapy increased four-fold during the FDS and there are case reports linking these drugs to neuropathy (21). However, such reports are rare and do not include CTS. Hypercholesterolemia may increase CTS risk (22) and it is possible that dyslipidemic patients were commenced on lipid-lowering therapy after experiencing significant

cholesterol-induced median nerve enlargement (22), with a subsequent paradoxical association between statin/fibrate use and CTD incidence.

Our study had limitations. We had no data on the prevalence and incidence of CTS, indication(s) for operation or relative frequency of clinical review that would have facilitated a more detailed analysis of the high CTD incidence compared to that in the general population. Nevertheless, our findings reflect the relative CTS prevalence in diabetes found previously (1-3). Strengths of the WADLS include its low coding error rate (23) and stable population base (24).

Because of its high prevalence (4), we recommend that CTS assessment for symptoms and signs of median nerve dysfunction should be part of regular complications screening in all type 2 patients. The present data suggest that many patients with CTS will require CTD for symptom relief.

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## References

1. Vinik A, Mehrabyan A, Colen L, Boulton A: Focal entrapment neuropathies in diabetes. *Diabetes Care* 27:1783-1788, 2004
2. Ashworth N: Carpal tunnel syndrome. *Am Fam Physician* 75:381-383, 2007
3. Burke FD: Carpal tunnel syndrome: reconciling "demand management" with clinical need. *J Hand Surg* 25:121-127, 2000
4. Dyck PJ, Kratz KM, Karnes JL, Litchy WJ, Klein R, Pach JM, Wilson DM, O'Brien PC, Melton LJ, 3rd, Service FJ: The prevalence by staged severity of various types of diabetic neuropathy, retinopathy, and nephropathy in a population-based cohort: the Rochester Diabetic Neuropathy Study. *Neurology* 43:817-824, 1993
5. Scholten R, Mink van der Molen A, Uitdehaag B, Bouter L, de Vet H: Surgical treatment options for carpal tunnel syndrome. *Cochrane Database Syst Rev*:CD003905, 2007
6. Bland JD: Treatment of carpal tunnel syndrome. *Muscle Nerve* 36:167-171, 2007
7. Mondelli M, Padua L, Reale F, Signorini AM, Romano C: Outcome of surgical release among diabetics with carpal tunnel syndrome. *Arch Phys Med Rehabil* 85:7-13, 2004
8. Davis TM, Zimmet P, Davis WA, Bruce DG, Fida S, Mackay IR: Autoantibodies to glutamic acid decarboxylase in diabetic patients from a multi-ethnic Australian community: the Fremantle Diabetes Study. *Diabet Med* 17:667-674, 2000
9. Norman PE, Davis WA, Bruce DG, Davis TM: Peripheral arterial disease and risk of cardiac death in type 2 diabetes: the Fremantle Diabetes Study. *Diabetes Care* 29:575-580, 2006
10. Holman CD, Bass AJ, Rouse IL, Hobbs MS: Population-based linkage of health records in Western Australia: development of a health services research linked database. *Australian and New Zealand Journal of Public Health* 23:453-459, 1999

11. Karpitskaya Y, Novak CB, Mackinnon SE: Prevalence of smoking, obesity, diabetes mellitus, and thyroid disease in patients with carpal tunnel syndrome. *Ann Plast Surg* 48:269-273, 2002
12. Perkins BA, Olaleye D, Bril V: Carpal tunnel syndrome in patients with diabetic polyneuropathy. *Diabetes Care* 25:565-569, 2002
13. Lam N, Thurston A: Association of obesity, gender, age and occupation with carpal tunnel syndrome. *Aust NZ J Surg* 68:190-193, 1998
14. Geoghegan JM, Clark DI, Bainbridge LC, Smith C, Hubbard R: Risk factors in carpal tunnel syndrome. *J Hand Surg* 29:315-320, 2004
15. de Krom MC, Kester AD, Knipschild PG, Spaans F: Risk factors for carpal tunnel syndrome. *Am J Epidemiol* 132:1102-1110, 1990
16. Gamstedt A, Holm-Glad J, Ohlson CG, Sundstrom M: Hand abnormalities are strongly associated with the duration of diabetes mellitus. *J Intern Med* 234:189-193, 1993
17. Singh R, Gamble G, Cundy T: Lifetime risk of symptomatic carpal tunnel syndrome in Type 1 diabetes. *Diabet Med* 22:625-630, 2005
18. Cagliero E, Apruzzese W, Perlmutter GS, Nathan DM: Musculoskeletal disorders of the hand and shoulder in patients with diabetes mellitus. *Am J Med* 112:487-490, 2002
19. Comi G, Lozza L, Galardi G, Ghilardi MF, Medaglini S, Canal N: Presence of carpal tunnel syndrome in diabetics: effect of age, sex, diabetes duration and polyneuropathy. *Acta Diabetol Lat* 22:259-262, 1985
20. Karalis DG: The role of lipid-lowering therapy in preventing coronary heart disease in patients with type 2 diabetes. *Clin Cardiol*, 2007 [Epub ahead of print] PMID: 17847038
21. Corrao G, Zambon A, Bertu L, Botteri E, Leoni O, Contiero P: Lipid lowering drugs prescription and the risk of peripheral neuropathy: an exploratory case-control study

- using automated databases. *J Epidemiol Community Health* 58:1047-1051, 2004
22. Nakamichi K, Tachibana S: Hypercholesterolemia as a risk factor for idiopathic carpal tunnel syndrome. *Muscle Nerve* 32:364-367, 2005
23. Norman PE, Semmens JB, Laurvick CL, Lawrence-Brown M: Long-term relative survival in elderly patients after carotid endarterectomy: a population-based study. *Stroke* 34:95-98, 2003
24. Bradshaw PJ, Jamrozik K, Jelfs P, Le M: Mobile Australians: a moving target for epidemiologists. *Med J Aust* 172:566, 2000

Table. Univariate baseline determinants of carpal tunnel decompression (CTD) in type 2 Fremantle Diabetes Study patients with no confirmed history of CTD. Data are proportions, mean ( $\pm$ SD), geometric mean (SD range), or median [inter-quartile range].

	No CTD	CTD	<i>P</i> value
Number	1217	67	
Age (years)	64.2 $\pm$ 11.3	60.4 $\pm$ 10.9	0.006
Male (%)	49.1	49.3	1.00
Diabetes duration (years)	4.0 [1.0-9.0]	3.3 [0.4-8.0]	0.24
Body mass index (kg/m <sup>2</sup> )	29.5 $\pm$ 5.5	31.2 $\pm$ 4.9	0.011
Fasting plasma glucose (mmol/L)	8.4 [6.8-10.8]	8.9 [7.3-10.8]	0.60
Glycated hemoglobin (%)	7.4 [6.4-8.8]	7.2 [6.4-8.4]	0.29
Diabetes treatment(%):			
Diet	31.9	34.3	
Oral hypoglycemic agents	56.2	53.7	0.91
Insulin $\pm$ oral hypoglycemic agents	12.0	11.9	
Systolic blood pressure (mmHg)	151 $\pm$ 24	150 $\pm$ 24	0.92
Diastolic blood pressure (mmHg)	80 $\pm$ 11	81 $\pm$ 9	0.65
On antihypertensive therapy (%)	51.0	46.3	0.46
Total serum cholesterol (mmol/L)	5.4 $\pm$ 1.1	5.7 $\pm$ 1.1	0.09
Serum HDL-cholesterol (mmol/L)	1.06 $\pm$ 0.33	1.03 $\pm$ 0.26	0.44
Serum triglycerides (mmol/L)	1.9 (1.1-3.3)	1.9 (1.2-3.3)	0.71
On lipid-lowering therapy (%)	10.0	22.4	0.004
On aspirin (%)	21.9	23.9	0.65
Urinary albumin:creatinine ratio (mg/mmol)	3.2 (0.7-13.9)	2.3 (0.6-8.3)	0.08
Any retinopathy (%)	16.9	9.1	0.12
Peripheral neuropathy (%)	31.3	22.7	0.17
Peripheral arterial disease (%)	29.8	22.7	0.27
Cerebrovascular disease (%)	10.2	4.5	0.14
Coronary heart disease (%)	31.6	31.3	1.00
Any exercise in past two weeks (%)	71.8	73.1	0.89
Smoking status (%):			
Never	44.2	50.7	
Ex-Current	40.2	43.3	0.10
Current	15.6	6.0	
Alcohol consumption (standard drinks/day)	0 [0-0.8]	0 [0-0.8]	0.91
Education to greater than primary level (%)	73.6	81.8	0.15
Not fluent in English (%)	15.7	9.0	0.16
Married/de facto relationship (%)	65.0	80.6	0.008
Household annual income $\leq$ AUD\$12,000 (%):	30.6	14.2	0.008
Ethnic background (%):			
Anglo-Celt	63.3	65.7	
Southern European	18.4	17.9	0.91
Other	18.3	16.4	
Self-reported and/or treated for hypothyroidism (%)	4.8	0	0.07
Self-reported arthritis (%)	53.0	61.2	0.21