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Review

Hand dysfunction in type 2 diabetes mellitus: Systematic review with meta-analysis

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Background: People with type 2 diabetes mellitus frequently show complications in feet and hands. However, the literature has mostly focused on foot complications. The disease can affect the strength and dexterity of the hands, thereby reducing function.
Objectives: This systematic review and meta-analysis focused on identifying the existing evidence on how type 2 diabetes mellitus affects hand strength, dexterity and function.
Methods: We searched MEDLINE via PubMed, CINHAL, Scopus and Web of Science, and the Cochrane central register of controlled trials for reports of studies of grip and pinch strength as well as hand dexterity and function evaluated by questionnaires comparing patients with type 2 diabetes mellitus and healthy controls that were published between 1990 and 2017. Data are reported as standardized mean difference (SMD) or mean difference (MD) and 95% confidence intervals (CIs).
Results: Among 2077 records retrieved, only 7 full-text articles were available for meta-analysis. For both the dominant and non-dominant hand, type 2 diabetes mellitus negatively affected grip strength (SMD: −1.03; 95% CI: −2.24 to 0.18 and −1.37, −3.07 to 0.33) and pinch strength (−1.09, −2.56 to 0.38 and −1.12, −2.73 to 0.49), although not significantly. Dexterity of the dominant hand did not differ between diabetes and control groups but was poorer for the non-dominant hand, although not significantly. Hand function was worse for diabetes than control groups in 2 studies (MD: −8.7; 95% CI: −16.88 to −1.52 and 4.69, 2.03 to 7.35).
Conclusion: This systematic review with meta-analysis suggested reduced hand function, specifically grip and pinch strength, for people with type 2 diabetes mellitus versus healthy controls. However, the sample size for all studies was low. Hence, we need studies with adequate sample size and randomized controlled trials to provide statistically significant results.

1. Introduction

Diabetes mellitus (DM) is a group of metabolic disorders characterized by chronic hyperglycaemia with disturbed carbohydrate, fat and protein metabolism due to absolute or relative deficiency in insulin secretion and/or action [1]. The prevalence of type 2 DM (T2DM) is increasing across the globe. According to the International Diabetes Federation, 415 million adults are estimated to have T2DM. One in 11 adults has T2DM. T2DM is more prevalent in low and middle socio-economic countries [2].

With the increase in prevalence of T2DM, complications associated with the disease also increase. The main reason for complications is poor glycaemic control and diabetes screening, especially in low socio-economic countries, lack of awareness among people, and lack of health care facilities in rural areas [3]. T2DM affects many parts of the body, the most common complications being diabetic cardiovascular problems, retinopathy, nephropathy, and peripheral neuropathy [4]. Peripheral

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neuropathy with a diabetes origin affects both upper and lower extremities. Throughout the literature, peripheral neuropathy of foot complications with T2DM are given much attention and less is known about peripheral neuropathy of the hand [5].

In T2DM, abnormal cross-linking of collagen fibres occurs due to accumulation of advanced glycosylation end-products, which leads to skin thickening and formation of nodules and contractures [6]. Commonly seen hand complications with T2DM are limited joint mobility syndrome, also known as diabetic cheiroarthropathy or stiff hand syndrome, Dupuytren's contracture, flexor tenosynovitis (trigger finger) and carpal tunnel syndrome [7].

Hand complications in patients with T2DM may affect activities of daily living and lead to disabilities in self-care activities. These result in reduced interpersonal interactions, loss of independence, financial burden and overall reduced quality of life [8]. However, we have little research pertaining to hand dysfunction in T2DM. With the increasing life expectancy and steep increase in number of people with T2DM, we need more research on hand function to address the standard of living and self-reliability in general and fine tasks.

With the increase in prevalence of T2DM worldwide and in India, the accompanying complications may disturb activities of daily living and quality of life. Unlike the diabetic foot, complications of hands with T2DM are easily neglected. Only a few studies have assessed hand strength, dexterity and dysfunction in people with T2DM. The reporting of hand dysfunction in these patients lacks agreement among studies. Thus, considering the increasing rate in number of people living with T2DM and the increased life expectancy, a study of hand function may help improve care, independence in activities of daily living and quality of life.

Hence, we performed a systematic review and meta-analysis to provide evidence of the effect of T2DM on hand strength, dexterity and function.

2. Methods

According to the Prisma statement, the review was performed for quality of reporting of a meta-analysis.

2.1. Literature search

We searched MEDLINE via PubMed, Scopus, Science Direct, Web of Science, Cochrane Central register of controlled trials, and CINHAL for articles published in English from June 1, 2017 to June 15, 2017 by using the MESH and keywords "type 2 diabetes mellitus", "hand dysfunction", "hand function", "hand strength", "hand dexterity", including the Boolean operator AND/OR. Full-text articles were selected for the review.

In the meta-analysis, we included articles with the following 3 criteria to achieve a homogenous sample for further analysis:

- participants had T2DM;
- age-matched controls were not diabetic or with impaired glucose tolerance;
- evaluation was of hand grip strength (with the hand Jamar dynamometer), pinch strength (pinch meter), and dexterity (Purdue Pegboard test), with hand function assessed by validated questionnaires.

2.2. Assessment of risk of bias

The included studies were assessed for risk of bias by using the US National Heart, Lung and Blood Institute checklist for observational cohort and cross-sectional studies. In the checklist, 6 questions were applicable to the current study. Questions 1 to 5 and 11 mainly focus on methodology: characteristics of the study population, rate of participation of eligible candidates, estimation of the sample size and adjustment for confounding factors. The quality assessment was performed by 2 independent reviewers. The scoring was Yes, No, cannot determine/not applicable or not reported. The study was rated as poor quality with score < 4; fair with score 4 to 5, and good with all scores ≥ 6. The mean score for the 2 reviewers was considered for each domain.

2.3. Study screening and data extraction

Two authors (GS and AM) independently screened all titles for inclusion. Abstracts of potentially eligible studies were obtained, then full texts. Any discrepancies between the authors were resolved by discussion. Data were extracted by the first author (GS) with the help of a qualified statistician.

3. Statistical analysis

Because all our outcomes were continuous, we calculated mean difference/standardised mean difference (MD/SMD) statistics. For the meta-analysis, we synthesized SMDs because the study authors used different instruments for measuring outcomes. For the studies not included in meta-analyses, we calculated MDs.

Meta-analysis was performed when at least 2 studies were similar in terms of the PICO process and study design providing relevant data. We adopted a random-effects model for the meta-analysis because we anticipated considerable heterogeneity among the studies. To assess heterogeneity, we used the Chi^2 statistic ($P < 0.1$ considered statistically significant) and evaluated heterogeneity with the I^2 statistic ($> 60\%$ considered substantial heterogeneity). Meta-analysis involved use of RevMan 5.2. We present forest plots for all meta-analyses. When meta-analysis was not appropriate, the effect size is presented with 95% confidence intervals (CIs). We performed meta-analysis of the effect of gender and age on grip strength of the dominant hand only because of few studies to analyse the effect size for other outcomes.

4. Results

4.1. Study selection

From the electronic database search, we identified 2077 articles; after removing duplicates and screening for eligibility criteria, 1579 articles were excluded. Overall, 24 full-text articles were eligible for review; 17 did not meet the inclusion criteria (Fig. 1), so finally, 7 articles were included in the final review and meta-analysis. Records were excluded because of inappropriate title and study methodology; no control group; improper study design and outcome measure, statistical analysis, and tools used in the study; inappropriate data; and publication language other than English.

4.2. Study quality

The studies included in the review showed fair quality according to the total score on the US National Heart, Lung and Blood Institute checklist (Table 1). None of the reports stated how the sample size was calculated to detect the clinically significant effect. Various confounding factors were not taken into consideration and could have influenced the outcome of interest.

4.3. Characteristics and recruitment of participants

A total of 761 participants were analysed: 425 in the study groups and 341 in the control groups. People with T2DM and

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