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Daily Step Count as a Simple Marker of Disease Severity in Hypertrophic Cardiomyopathy

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Background

Individuals with hypertrophic cardiomyopathy (HCM) may be asymptomatic or display activity-limiting symptoms. A common cause of symptoms is left ventricular outflow tract obstruction (LVOTO), which may impact the individuals' ability to undertake physical activity. This study sought to examine daily step count as a potential marker of exercise capacity, which may represent a proxy marker of disease severity in HCM.

Methods

A cross-sectional study of 63 HCM patients was conducted from March to November 2015. Participants wore an ActiGraph GT3X+ (Pensacola, Florida, USA) accelerometer for 7 days. Minutes per day of light, moderate and vigorous physical activity and step count were calculated, and those with LVOTO were compared to those without. Similarly, those with good functional capacity (New York Heart Association; NYHA class I) were compared to those with NYHA class II–IV.

Results

The majority of HCM patients were male ($n = 45$, 71%) with mean age of 48.8 ± 14.9 years. Hypertrophic cardiomyopathy patients with history of LVOTO and those NYHA class II–IV took significantly fewer steps per day (LV obstruction: 5527 ± 2370 versus 7027 ± 2095 , $p = 0.01$ and NYHA: 5346 ± 1898 versus 6801 ± 2339 , $p = 0.03$). No differences were observed across the different intensities of physical activity.

Conclusions

Measurement of daily step count may be a useful and simple tool to determine exercise capacity and provide an indicator of disease severity in individuals with HCM.

Keywords

Hypertrophic cardiomyopathy • Accelerometry • Step count

Introduction

Hypertrophic cardiomyopathy (HCM) is an inherited heart disease with prevalence of up to 1:200 people [1]. Individuals with HCM may be asymptomatic and diagnosed incidentally or as a result of family screening. Alternatively, patients may present with symptoms leading to cardiac investigations and diagnosis of HCM [2].

Symptoms related to HCM include dyspnoea and chest pain, and can be induced by left ventricular outflow tract obstruction (LVOTO) [3]. LVOTO is defined as a resting systolic pressure gradient in the outflow tract of greater than 30 mmHg, or an inducible gradient of greater than 50 mmHg [3,4]. Presence of symptoms may impact on the individuals' ability to undertake physical activity, leading to physical inactivity and potentially, development of

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non-communicable diseases such as diabetes and ischaemic heart disease [5].

The New York Heart Association (NYHA) classification is used to categorise patients based on severity of symptoms [6]. In general, those with LVOTO more often have severe symptoms resulting in a higher NYHA class, however, this is not always the case [4]. Simple methods that quantify physical activity levels may be helpful at the clinical level in the context of HCM and patient management decisions. Daily step count is a simple measure that can be obtained easily through use of a pedometer or activity tracker device. This study sought to examine daily step count as a potential marker of disease severity and exercise capacity in the setting of HCM.

Methods

A cross-sectional study of consecutive HCM patients attending the HCM and Genetic Heart Disease Clinics at Royal Prince Alfred Hospital, Sydney, Australia was conducted from March 2015 to November 2015. The methods including study cohort have been reported previously in the setting of overall physical activity behaviours in HCM [7]. Participants were requested to wear a hip-mounted ActiGraph GT3X+ accelerometer (Pensacola, Florida, USA) for a minimum of 7 days during waking hours. The ActiGraph records physical activity as 'activity counts per minute', allowing for measurement of light (e.g. a gentle stroll), moderate (e.g. a brisk walk/slow jog), and vigorous activity (e.g. running), and step count.

Descriptive statistics (mean and standard deviation) were used to examine cohort characteristics. Minutes of light, moderate, and vigorous physical activity per day were calculated using the ActiLife software (V 6.13.3). Steps per day were calculated by dividing the total number of steps by the number of days of wear time. Students' t tests were used to compare physical activity outcomes in those with a history of LVOTO to those without, and in those with NYHA class I with those of NYHA class II–IV. Sensitivity and specificity were examined using receiver operating characteristic (ROC) analyses. Data were analysed using Stata V.14.1 (StataCorp, Texas, USA). This study was approved by the Sydney Local Health District Ethics Review Committee and all patients gave informed consent.

Results

Valid accelerometer data was available on 63 HCM patients. Cohort characteristics are summarised in Table 1. The majority of participants were male (71%) with a mean age of 48.8 ± 14.9 years and body mass index (BMI) of 27.9 ± 5.1 (i.e. overweight category). Over one third (36.5%) had an implantable cardioverter defibrillator *in situ* and 54% were on beta-blocker medication. A quarter of participants (25%) had an NYHA class greater than one (NYHA class II,

Table 1 HCM cohort characteristics.

Characteristic	Total cohort
Total HCM participants	63
Males, n (%)	45 (71.1%)
Age (yrs), mean \pm SD	48.8 ± 14.9
BMI (kg/m^2), mean \pm SD	27.9 ± 5.1
ICD <i>in situ</i> , n (%)	23/63 (36.5%)
Beta blockers, n (%)	34/63 (54.0%)
Co-morbidities, n (%)	39/60 (65.0%)
NYHA class II–IV	16/63 (25.4%)
Max. LVH (mm), mean \pm SD	21.4 ± 5.8
NSVT, n (%)	13/63 (20.6%)
Hx of syncope, n(%)	9/56 (16.1%)
Hx of LV outflow tract obstruction, n (%)	25/63 (39.7%)
Max gradient (mm/Hg), mean \pm SD	47.1 ± 52.2
Atrial fibrillation	10/63 (15.9%)
Surgical myectomy or ablation, n (%)	8/60 (13.3%)
Family Hx SCD, n (%)	9/62 (14.5%)

Abbreviations: HCM, hypertrophic cardiomyopathy; BMI, body mass index; ICD, implantable cardioverter defibrillator; NYHA, New York Heart Association class; LVH, left ventricular hypertrophy; NSVT, non sustained ventricular tachycardia; LV, left ventricular; SCD, sudden cardiac death.

n = 15; NYHA class III, n = 1) and 40% had resting LVOTO. Co-morbidities such as cancer, mental health problems and diabetes were present in 65%.

No differences in duration of physical activity of any intensity were observed in either the LVOTO or NYHA class sub-group analyses. However, significant differences were observed when looking at step count (Table 2). Those with an NYHA class II–IV took significantly fewer steps per day, compared to those with NYHA class I (5346 ± 1898 versus 6801 ± 2339 steps, $p = 0.03$). Similarly, those with LVOTO performed fewer steps per day than those without LVOTO (5527 ± 2370 versus 7027 ± 2095 steps, $p = 0.01$). A history of LVOTO was significantly associated with NYHA class II–IV ($p = 0.006$).

Receiver operating characteristic curves examining daily step count and LVOTO, and daily step count and NYHA class II–IV showed low sensitivity but high specificity for both curves (AUC = 0.3063 and 0.3125, respectively).

Discussion

We suggest that those with LVOTO or NYHA class II–IV take fewer steps per day than those without obstruction or NYHA class I. Based on accelerometry, the current study indicates that measurement of daily step count may be a useful tool to determine exercise capacity and provide an indicator of disease severity in individuals with HCM. At a clinical level, the high specificity for both history of LVOTO and NYHA class II–IV indicate that patients with either of these characteristics may not undertake sufficient steps per

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