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Postprandial effects of potassium supplementation on vascular function and blood pressure: a randomised cross-over study

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Abstract *Background and aims:* Endothelial dysfunction, as assessed by flow mediated dilatation (FMD) is an early event in atherosclerosis and an independent predictor of cardiovascular events. The effect of potassium supplementation on endothelial function and blood pressure (BP) in the postprandial state is not known. The aim of this study was to assess endothelial function using FMD in healthy volunteers.
Methods and results: Thirty-two normotensive volunteers received a meal with 36 mmol potassium (High K) and a control 6 mmol potassium (Low K) meal on 2 separate occasions in a randomized order. FMD and BP were measured while participants were fasting and at 30, 60, 90 and 120 min after the meal. There was a postprandial decrease in FMD in both groups. FMD decreased overall less after the High K meal compared to the Low K meal (meal effect $p < 0.05$). Both meals produced a postprandial decrease in BP at 30 min which returned to baseline levels by 120 min. No significant differences in BP were observed between meals. FMD and systolic BP were negatively correlated at 90 ($r = -0.54$–0.55, $p < 0.01$) and 120 min ($r = -0.42$–0.56, $p < 0.01$) after both meals.
Conclusions: A high potassium meal, which contains a similar amount of potassium as 2.5 serves of bananas, can lessen the postprandial reduction in brachial artery FMD when compared to a low potassium meal.

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Introduction

Endothelial dysfunction is an early event in atherosclerosis and can be measured long before clinical manifestation of the disease [1]. Flow mediated dilatation (FMD) is a reliable, non-invasive technique used to assess vascular endothelial function. FMD correlates well with invasive endothelial function tests and the extent/severity of atherosclerosis [2]. This measure is also correlated with cardiovascular disease and strongly predicts cardiovascular events in patients with established CVD [3]. FMD has been used to measure reversibility of endothelial dysfunction in response to a variety of therapies [2]. Limitations of the technique include the difficulty of the technique to perform and the varying responses of different vascular areas to different stimuli [4], which can affect reproducibility [2]. For these reasons FMD is only indicated for clinical research rather than routine clinical practice [2]. The measurement of endothelial function by FMD in the conduit arteries of the peripheral circulation allows the study of vascular biology in healthy subjects in whom invasive testing is not feasible [5].

A diet high in potassium is associated with positive effects on cardiovascular health [6]. A recent meta-analysis of more than 250,000 individuals, pooled from 11 published studies concluded that an increase in intake of 1.3–1.4 g potassium daily, from fruit, vegetables and wholegrains can reduce the risk of coronary heart disease (CHD) by 7% and the risk of cardiovascular disease (CVD) by 26% [7]. Other evidence suggests that fruit and vegetable intake is inversely associated with CVD risk [8] and while several nutrients may contribute to this beneficial effect (e.g. potassium, magnesium folate, fibre, polyphenols), potassium is considered to be a major contributing factor [9]. However the mechanisms of the beneficial effects of potassium remain unclear. A 2006 Cochrane review found the evidence for a potential beneficial effect of potassium on blood pressure (BP) was inconclusive and recommended further high quality randomised controlled trials with longer duration to determine any effect [10]. In addition investigations into the effects of potassium on vascular function report varied results. He et al. [11] demonstrated that potassium supplementation for 4 weeks improved endothelial function assessed in the fasting state in individuals with mildly raised BP. In contrast Berry et al. [12] found no effect on BP or vascular function by increasing dietary potassium for 6 weeks.

On a cellular level, potassium has been shown to have beneficial effects on endothelial cells [13]. Oberleithner et al. [13] found that an increase in extracellular potassium concentration (within the normal physiological range) significantly diminished the stiffness of endothelial cells and improved the release of nitric oxide (NO).

To our knowledge the effects of potassium on endothelial function in the post-prandial state have not been studied. The aim of this study is to investigate the post-prandial effects on endothelial function of potassium (equivalent to that found in 2–3 pieces of fruit) in a single meal. Given the associations between potassium intake and vascular health, our hypothesis was that potassium supplementation would improve endothelial function in the postprandial state. Our secondary aim was to investigate the postprandial effects of potassium on blood pressure.

Subjects and methods

Study population

Thirty-two men and women aged between 18 and 70 y were recruited through personal contact and advertisement on community notice boards. Of the 60 people who responded, 32 were enrolled and completed the study, 14 were excluded and 14 were not screened as sufficient numbers had been enrolled to meet calculated power. Inclusion criteria were body mass index (BMI; in kg/m^2) $\geq$18 and $\leq$30, systolic BP (SBP) $<$ 130 mmHg, diastolic BP (DBP) $<$ 90 mmHg, weight stability in the preceding 6 months, and no use of antihypertensive or cholesterol lowering medication, systemic steroids, non-steroidal anti-inflammatory drugs or folate supplementation. Participants were not excluded if they were taking any other vitamin supplements, provided the dose was kept constant for the duration of the study. Exclusion criteria were known metabolic disease such as liver or kidney disease, treated hypertension, known or treated high cholesterol (total

Table 1 Measures of vascular function and blood pressure at baseline and the beginning of each intervention[a].

	Initial visit	Low K	High K	p[b]
Age	33.7 ± 11.6	–	–	
BMI (kg/m^2)	22.9 ± 2.6	–	–	
Weight (kg)	68.3 ± 14.3	68.2 ± 14.1	68.2 ± 14.1	0.66
SBP (mm Hg)	111 ± 8	111 ± 9	111 ± 8	0.608
DBP (mm Hg)	70 ± 8	70 ± 8	69 ± 8	0.607
MAP (mm Hg)	83 ± 7	83 ± 8	83 ± 8	0.573
Fasting BA diameter (mm)	3.9 ± 0.8	3.9 ± 0.8	4.0 ± 0.7	0.144
Post release BA diameter (mm)	4.3 ± 0.8	4.2 ± 0.8	4.2 ± 0.8	0.589
FMD (%)	8.0 ± 2.2	8.1 ± 2.5	8.1 ± 2.6	0.952

SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; BA, brachial artery; FMD, flow mediated dilatation.

[a] All values are means ± SDs.

[b] Paired students t test n = 32 (19 women and 13 men).