Journal of the American Society of Hypertension 9(4) (2015) 275–284

Research Article

Relationship between different blood pressure measurements and left ventricular mass by cardiac magnetic resonance imaging in end–stage renal disease

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Manuscript received November 7, 2014 and accepted January 19, 2015

Abstract

Hypertension is prevalent in patients with end–stage renal disease and is strongly associated with left ventricular hypertrophy (LVH), an independent predictor of cardiovascular mortality. Blood pressure (BP) monitoring in hemodialysis patients may be unreliable because of its lability and variability. We compared different methods of BP measurement and their relationship with LVH on cardiac magnetic resonance imaging. Sixty patients undergoing chronic hemodialysis at a single dialysis center had BP recorded at each dialysis session over 12 weeks: pre–dialysis, initial dialysis, nadir during dialysis, and post–dialysis. Forty–five of these patients also underwent 44–hour inter–dialytic ambulatory BP monitoring. Left ventricular mass index (LVMI) was measured using cardiac magnetic resonance imaging and the presence of LVH was ascertained. Receiver operator characteristic curves were generated for each BP measurement for predicting LVH. The mean LVMI was 68 g/m^2 (SD = 15 g/m^2); 13/60 patients (22%) had LVH. Mean arterial pressure measured shortly after initiation of dialysis session was most strongly correlated with LVMI (Pearson correlation coefficient r = 0.59, $P < .0001$). LVH was best predicted by post–dialysis systolic BP (area under the curve, 0.83; 95% confidence interval, 0.72–0.94) and initial dialysis systolic BP (area under the curve, 0.81; 95% confidence interval, 0.70–0.92). Forty–four–hour ambulatory BP and BP variability did not significantly predict LVH. Initial dialysis mean arterial pressure and systolic BP and post–dialysis systolic BP are the strongest predictors of LVH, and may represent the potentially best treatment targets in hemodialysis patients to prevent end–organ damage. Further studies are needed to confirm whether treatment targeting these BP measurements can optimize cardiovascular outcomes. J Am Soc Hypertens 2015;9(4):275–284.

Keywords: Hemodialysis; hypertension; left ventricular hypertrophy; mean arterial pressure.

This study was supported by an operating grant from the Canadian Institutes of Health Research (MOP 89982).

Conflict of interest: none.

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1933-1711/$ - see front matter
http://dx.doi.org/10.1016/j.jash.2015.01.011

Introduction

Cardiovascular disease is the leading cause of mortality and hospitalization in patients undergoing chronic hemodialysis (HD).[1–5] Cardiovascular risk factors continue to be relatively under–treated,[6] and hypertension is common in the end–stage renal disease (ESRD) population with an estimated prevalence of 50%–80%.[6]

In HD patients, blood pressure (BP) is partly related to extracellular volume status, which is largely dependent on the timing, frequency, and adequacy of dialysis.[7] Since 2009, the Canadian Hypertension Education Program (CHEP) has recommended targeting a BP of less than 140/90[8]; however, there is no consensus on when to measure BP—before, during, or after dialysis—and more importantly, which reading best correlates with cardiovascular outcomes. Current practice guidelines recommend using pre–dialysis systolic BP (SBP) to guide treatment of hypertension based on Grade C level evidence.[9]

Several studies have shown a close relation between BP and left ventricular mass (LVM)[10,11] and left ventricular hypertrophy (LVH), which is strongly associated with cardiovascular events in patients with and without kidney disease.[12,13] Furthermore, change in LVM has been used as a primary surrogate endpoint for therapeutic interventions in landmark trials of renal replacement therapies.[14,15] Conversely, LVM regression is associated with favorable outcomes, including decreased likelihood of developing heart failure and lower all–cause mortality.[16,17] Currently, cardiac magnetic resonance imaging (CMR) provides the most accurate and reproducible measurement of LVM.[18,19]

Although BP is an important and modifiable risk factor for cardiovascular disease in dialysis recipients, it is not clear which BP measurements should be used for therapeutic guidance. Given the clinical significance of LVH as a marker of end–organ damage and predictor of adverse cardiovascular events, the objective of this study was to evaluate the relationship between different BP measurements (pre–dialysis, initial dialysis, nadir dialysis, post–dialysis, inter–dialytic ambulatory) and LVM, as measured by CMR, in recipients of conventional HD.

Methods

Study Design

This was a cross–sectional study based on a single tertiary–center cohort of 60 prevalent in–center HD patients at St Michael's Hospital in Toronto, Canada. All patients were receiving conventional HD (4 hours per session, 3–4 times weekly) at the time of assessment. Participants were recruited for an observational study comparing the cardiovascular impact of conversion to in-center nocturnal HD versus continuation of conventional dialysis. The data included herein reflect the baseline data for all study participants who were receiving conventional HD. Adults 18 years or older with ESRD who were receiving conventional HD for at least 3 months were eligible for this study. Exclusion criteria for the study were any serious co–morbidity with a life expectancy of less than 1 year, a planned live donor kidney transplant within the next 12 months, contraindications to CMR, pregnancy, or inability to provide informed consent. BP data were collected during all dialysis sessions during a 12–week period.

Patient Demographic Data

A chart review was performed for each patient via the St Michael's Hospital electronic patient record system. We collected demographic and clinical data, which included age, gender, cause of ESRD, dialysis vintage, type of vascular access, history of coronary artery disease (defined as previous myocardial infarction or revascularization), cerebrovascular disease (history of documented stroke), diabetes, and peripheral vascular disease (amputation or peripheral revascularization). Relevant medications were also recorded including beta blockers, renin–angiotensin–aldosterone system (RAAS) blocking agents, cholesterol lowering agents, antiplatelet agents, anticoagulants, erythropoietin stimulating agents, and phosphate binders.

In–center Blood Pressure and Weight Measurements

BP readings were collected retrospectively from dialysis treatment records over a 12–week period prior to CMR. These were routine blood pressure measurements taken by the dialysis nurses as part of standard dialysis care, using automated BP monitors built into the dialysis machines (Phoenix, Gambro, Richmond Hill, ON). A pre–dialysis BP was measured upon patient arrival in the dialysis unit but prior to the start of dialysis. Upon initiation of dialysis, the first recorded BP reading taken was termed the "initial dialysis BP"; this was taken within the first 15 minutes after the HD circuit was initiated; subsequent BP measurements were taken every hour and at the nurse's discretion. Post–dialysis BP was measured after cessation of dialysis within 15 minutes. The lowest BP reading measured at any point during the dialysis session was considered the "nadir BP." Corresponding pulse rates were recorded with each BP reading. The dialysis records also contained information on pre–dialysis and post–dialysis weight, as well as volume of ultra–filtration achieved in each session. Inter– and intra–dialytic weight changes were calculated from these data.

Ambulatory Blood Pressure Monitoring

Ambulatory blood pressure monitoring (ABPM) data were acquired over a 44–hour period. The duration of