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Research Article

The Impact of Routine Focused Transthoracic Echocardiography Immediately before Renovascular Surgery in Patients with End Stage Renal Disease– A Brief Report

Jennifer Lucas[1]* and David J Canty[1,2,3]

[1]*Consultant Anaesthetist, Department of Anaesthesia and Perioperative Medicine, Monash Medical Centre, Melbourne, Australia*
[2]*Senior Lecturer, Department of Surgery, University of Melbourne, Australia*
[3]*Consultant Anaesthetist, Department of Anaesthesia and Pain Management, Royal Melbourne Hospital, Parkville, Australia*

***Corresponding author**
Dr. Jennifer A Lucas, MBBS FANZCA, Consultant Anaesthetist, Department of Anaesthesia and Perioperative Medicine, Monash Medical Centre, Melbourne, Australia, Email: drjennilucas@yahoo.com.au

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Abstract

Background: Patients with end stage renal disease (ESRD) have a high incidence of postoperative cardiac morbidity and mortality. The frequent presence of cardiac disease, extreme states of hydration and reduced ability to excrete a fluid load pose challenges to anesthetic management. Routine preoperative focused transthoracic echocardiography (TTE) may assist in improved cardiac and hemodynamic state assessment directing more rational anesthetic care in these high-risk patients.

Methods: An audit was performed on focused TTE performed by an anesthesiologist immediately before renovascular surgery in 18 sequential patients with ESRD. Data recorded included the quality and time to acquire echocardiography images and their influence on anesthetic management.

Results: Interpretable images were obtained in 15 of 18 patients during the study period (83%). Hypovolemia was revealed in 33%, which lead to an intravascular fluid bolus immediately before surgery.

Conclusion: Routine anesthesiologist-performed preoperative focused TTE detected hypovolemia and facilitated anesthetic management in one third of patients with ESRD presenting for renovascular surgery.

INTRODUCTION

Traditionally, preoperative transthoracic echocardiography (TTE) is requested to facilitate non-invasive assessment and optimization of cardiac disease prior to anesthesia and surgery in patients deemed to be at increased cardiac risk. A subsequent TTE report from the echocardiography laboratory may assist anesthetic management by quantification of ventricular or valve function, however it is not always available before surgery [1]. Recent studies report more liberal use of qualitative or 'focused TTE' by anesthesiologists, which changed management in approximately 50% of selected patients at higher cardiac risk before elective non-cardiac surgery [2]. In addition to improved diagnosis of cardiac pathology compared with clinical examination, identification of abnormal hemodynamic states such as hypovolemia, vasodilation and pulmonary hypertension frequently guided hemodynamic interventions before anesthesia and surgery [3,4] and may even have resulted in lower mortality [5]. Management changes after TTE were also common (10-30%) in patients aged over 65 years who were asymptomatic of cardiac disease [2,3]. This raises the question whether focused TTE should be a routine part of the preoperative examination as an extension of the clinical history and examination ('ultrasound assisted examination') [6]. Selected use of focused TTE by non-cardiologists has recently been recommended by the American Society of Echocardiography [7], but routine echocardiography reports are limited to patients admitted to intensive care [8].

Patients with ESRD requiring non-cardiac surgery are a high-risk patient group that may benefit from preoperative focused TTE. Cardiac disease is common in these patients, the principal contributor to an in-hospital mortality after non-cardiac surgery of five fold that of patients without ESRD [9,10]. Their state of hydration is frequently at extremes (pulmonary edema due

to overdue dialysis or hypovolemia shortly after dialysis), which is often difficult to assess clinically and has important consequences for acute perioperative management. Focused TTE provides direct assessment of left ventricular volume [11], avoiding the uncertainty of clinical assessment and allowing preoperative optimization of fluid volume which may ameliorate hemodynamic instability.

The aim of the study was to determine whether *routine* preoperative focused TTE by an anesthesiologist is feasible and significantly influences the anesthetic management in patients with ESRD presenting for renovascular surgery, particularly perioperative management of *intravascular volume.*

MATERIALS AND METHODS

The IRB approved this study as an audit without the requirement for written patient consent. All patients who required renovascular surgery by a single surgeon and anesthesiologist scheduled on a weekly operating session between October 2012 and February 2013 at Monash Medical Centre (Melbourne), a tertiary referral University teaching hospital, were prospectively included. After preoperative patient clinical assessment, the anesthesiologist recorded their management plan. After verbal consent from the patient, the same anesthesiologist then performed TTE and recorded any subsequent change in anesthesia management as a result of the TTE.

The anesthesiologist had received basic training in focused TTE consistent with local practice guidelines[12]. Focused TTE was performed using a Mindray Diagnostic Ultrasound system (Mindray, Shenzen, China,) with a 2-4 MHz transthoracic probe and followed the HEARTscan protocol [13] with particular attention to hemodynamic state, including left ventricular preload, systolic function and afterload. Quantification of valve function was not assessed formally.

The primary endpoint was the difference in anesthesia management plan after TTE such as altered surgical workflow (cancellation or prevention of cancellation in surgery for further assessment, or postoperative high dependency care), altered anesthesia type (general or regional anesthesia) or hemodynamic management (changes in fluid therapy, use of arterial catheter or hemodynamic drugs). Specifically, the assessment of patient's intravascular fluid status was compared before and after focused TTE, as this assessment is frequently difficult in or uninterruptable). patients with ESRD.

Secondary endpoints included the time to perform TTE and the quality of images (interpretable or uninterpretable). Echocardiography images were considered interpretable if hemodynamic state was assessable.

This study represents the initial or pilot phase of a longer-term project to identify the benefit of anesthesiologist-performed TTE in patients with ESRD.

RESULTS

Eighteen patients scheduled for renovascular surgery over the study period were included in the study. Surgery included, alone or in combination, long-term hemodialysis vascular catheter insertion or removal (5), peritoneal dialysis catheter insertion (1), creation or revision of arteriovenous fistula (13) and one patient who received a renal transplant. The median creatinine clearance was 7 ml/min/m^2.

Median (SD) age was 62 (10.7) years, of whom the majority were male (14). Significant morbidity was common and included diabetes requiring insulin (11) or oral hypoglycaemic medication (1), hypertension (9), significant cardiac disease (7), and morbid obesity (BMI> 40kg/m^2) in 3 patients.

Focused TTE was interpretable in 15 of the 18 patients included in the study (83%). Imaging was uninterpretable in two patients due to body habitus (one obese, the other extremely thin), and was not attempted in one patient due to time pressures. Following TTE, the anesthesiologist changed their management in 6 patients (40%), as shown in Table 1. The most frequent abnormality on TTE was hypovolemia that was not suspected on clinical examination, which was found in 5 (33%) patients, who all received a fluid bolus in an attempt to restore circulating blood volume and prevent hemodynamic instability before anesthesia and surgery. In the sixth patient the anesthesiologist was concerned of the presence of hypovolaemia (tachycardia), however TTE confirmed normal ventricular function and volume. This reassured the anesthesiologist who instead diagnosed patient anxiety and the tachycardia resolved with intravenous midazolam.

Median time (range) for performance of a focused TTE was 7:07 (5:55 – 11:56) minutes. There was no delay or overrun in the operating theatre sessions associated with performance of TTE.

DISCUSSION

Routine preoperative focused TTE used as an extension of clinical examination of the anesthesiologist was feasible in a high proportion of a sequential cohort of patients with ESRD presenting for renovascular surgery. TTE frequently revealed hypovolemia that was not suspected clinically, which lead to an intravascular fluid bolus before anesthesia and surgery. Other management changes previously reported from focused TTE in non-cardiac surgery patients [2] were not evident in this series. Performance of TTE was not lengthy and did not adversely affect surgical workflow.

Traditionally patients with ESRD requiring non-cardiac surgery are provided with restrictive fluid therapy by the anesthesiologist for fear of overtransfusion, which could result in acute pulmonary edema. This study demonstrated that hypovolemia was common, which if left undetected may increase the risk of perioperative hypotension and impaired organ perfusion, especially in the presence of significant cardiac disease. Conversely, improved detection of fluid overload by preoperative TTE in ESRD patients could be clinically useful as this would provide a compelling reason to delay surgery until excess fluid is removed with hemodialysis, although this was not demonstrated in this study. Unlike other minimally invasive cardiac output monitors (eg. esophageal Doppler), TTE additionally identifies the *cause* of reduced cardiac output (diagnosis of hemodynamic state and valvular disease) which is obtained *before* commitment to anesthesia, encouraging proactive treatment as opposed to reacting to intraoperative hypotension. An additional advantage

Table 1: Focused transthoracic echocardiography findings that influenced anesthetic management decisions in 6 patients out of 18 requiring renovascular surgery.

Surgical Procedure	Known co-existing disease	TTE findings	Altered management
Insertionof haemodialysis access catheter	ESRD, IDDM	Hypovolemia; Normal LV function	Fluid bolus
Removalof haemodialysis access catheter; Arteriovenous fistula formation	ESRD, IDDM, morbid obesity	Hypovolemia; Normal LV function	Fluid bolus
Revisionof arteriovenous fistula	ESRD, IHD	Hypovolemia; Normal LV function	Fluid bolus
Arteriovenous fistula formation	ESRD, NIDDM, HPT	Hypovolemia; Normal LV function; Rapid AF	Fluid bolus, Metoprolol
Arteriovenous fistula formation	ESRD, HPT	Hypovolemia; Normal LV function	Fluid bolus
Insertionof haemodialysis access catheter	ESRD, IDDM, IHD	Normal LV volume and LV function	Anxiolysis

TTE; transthoracic echocardiography, ESRD; end stage renal disease, IDDM; insulin dependent diabetes mellitus, LV; left ventricle, IHD; ischaemic heart disease, HPT; hypertension.

of TTE in ESRD patients is the avoidance of insertion of an arterial catheter (as is required for pulse contour analysis), thus preserving the vessel for future arteriovenous fistula formation.

Limitations of the study include a single anesthesiologist performing clinical assessment, management and TTE, as the findings are subjective and prone to bias. As the TTE was not comprehensive, important cardiac pathology may have been missed. The same conclusions may have been reached clinically by an experienced anesthesiologist familiar with the patient complexities and the demands of renovascular surgery. It is unclear whether the changes in management, i.e. increased fluid therapy, due to the TTE findings altered patient outcome as the study was not designed for this purpose. However this may be a worthwhile avenue of research, as improved postoperative quality of recovery has been demonstrated in several studies of intraoperative goal-directed fluid therapy in major non-cardiac surgery[14].

CONCLUSIONS

In conclusion, routine preoperative focused TTE by an anesthesiologist was feasible and influential in anesthetic management of end stage renal disease patients requiring renovascular surgery.

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