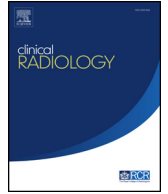


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Evaluation of a single-pass with biphasic intravenous contrast medium injection CT protocol for the assessment of complications post-simultaneous pancreas–kidney transplant

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AIM: To evaluate the use of a single-pass with biphasic intravenous contrast medium injection computed tomography (CT) protocol to provide diagnostic quality CT studies for the assessment of complications post-simultaneous pancreas–kidney transplant (SPK).

MATERIALS AND METHODS: This was an audit of practice and the need for informed consent was waived. The protocol was used in consecutive patients undergoing CT to exclude intra-abdominal sepsis post-SPK between June and December 2015. Single CT acquisition of the abdomen and pelvis was initiated 70 seconds after the start of biphasic contrast medium injection (66 ml at 1.2 ml/s, followed by 34 ml at 2.4 ml/s, 370 mg iodine/ml). The named transplant pancreas vessels were identified and the attenuation values of the blood within were measured. Diagnostic quality was confirmed if values were >211 HU and >80 HU in the arteries and veins, respectively.

RESULTS: Thirteen CT studies were performed in 10 patients. CT studies were excluded due to complete pancreatic necrosis, and transplant superior mesenteric artery (SMA) thrombus with pancreatic head ischaemia causing effacement of the transplant superior mesenteric vein (SMV). Diagnostic quality of the analysed CT studies were confirmed with mean attenuation value of blood >211 HU in the transplant pancreatic arteries (SMA=259.0±51.4 HU, splenic artery=245.3±37.5 HU), and >80 HU in the pancreatic veins (SMV=195.4±36.2 HU, splenic vein=185.1±54.2 HU).

CONCLUSION: Diagnostic quality CT studies were obtained using the single-pass CT protocol. Radiation exposure to patients may be reduced with this protocol, while permitting simultaneous assessment of parenchymal and vascular complications post-SPK.

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Introduction

Pancreas transplantation is performed with the aim of restoring physiological normoglycaemia to reduce complications in patients with insulin-dependent diabetes.^{1,2}

Simultaneous pancreas–kidney transplant (SPK) represents the most common form of pancreas transplantation with alternatives including: pancreas transplant alone or pancreas after kidney transplant.³ In view of the benefits of SPK over deceased donor kidney (alone) transplant,^{3,4} SPK is also considered in type I diabetic patients <55 years with end-stage renal failure secondary to diabetic nephropathy. Although serum creatinine provides an insight into graft function post-SPK, clinical assessment of the pancreas graft remains challenging and radiological evaluation plays a vital role.

Ultrasound assessment of pancreas graft is popular due to low cost, repeatability, and portability; however, formal assessment may be hindered by overlying bowel gas limiting visualisation of the parenchyma and vasculature,⁵ which can be overcome by computed tomography (CT). Additionally, the larger imaging field of CT is also superior to ultrasound in assessing complications related to the duodenal stump and recipient small bowel.^{6–8} Although some centres refrain from using iodinated intravenous contrast agents due to potential deleterious effect on the function of the transplant kidney,⁹ multiphasic contrast-enhanced CT is routinely performed at our institution when assessing for complications post-SPK. The benefit of using iodinated contrast agent is perceived to outweigh the potential risk, especially with vascular complications representing one of the major complication groups post-SPK. With the majority of recipients falling into the younger age group, risks associated with radiation exposure should also be carefully considered.

Initially described by Nguyen *et al.*,¹⁰ biphasic intravenous contrast medium injection with single-pass whole-body CT acquisition has been shown to achieve optimal enhancement of visceral organs and vessels for assessment of the thorax and abdomen in trauma. This protocol has been revisited in later studies, which have confirmed improved vascular and abdominal parenchymal imaging compared to the conventional protocol of arterial-phase contrast-enhanced CT examination of the thorax, followed by portal venous phase of the abdomen and pelvis.^{11–13} As the protocol provides both arterial and portal venous phase images during the single-pass CT acquisition, a reduction in radiation exposure has also been observed compared to the conventional protocol.^{11,13,14} A similar CT protocol may be used in patients following SPK, permitting the assessment of parenchymal, as well as both arterial and venous vascular complications during single-pass CT acquisition. This CT protocol may remove the need for multiphasic contrast-enhanced CT, with consequent reduction in patient radiation exposure.

The current study evaluated the feasibility of using a single-pass CT protocol with biphasic intravenous contrast medium injection to provide diagnostic-quality CT studies for the assessment of complications post-SPK. The diagnostic quality of the CT studies with the new protocol was determined by measuring the attenuation values of blood within transplant pancreas vessels. Interval change in renal function pre- and post-CT was also compared to determine

any impact resulting from intravenously injection of contrast medium.

Materials and methods

The new protocol was evaluated in post-SPK patients undergoing CT to exclude intra-abdominal sepsis post-operatively. Patients investigated for possible vascular complications post-transplant were excluded. Application of the new CT protocol was the only deviation from the patient's standard clinical care, the institutional review board categorised this study as service evaluation, and formal informed consent was not required.

The protocol was used in all patients undergoing CT to exclude intra-abdominal sepsis post-SPK between June 2015 and December 2015. The biochemical and radiological data of these patients were reviewed retrospectively. The pre- and post-CT estimated glomerular filtration rate (eGFR) and creatinine, as well as the attenuation value measurements of blood in the transplant pancreas vessels were recorded respectively for analysis.

CT protocol

The contrast medium injection was biphasic using a pump injector (Medrad Stellant D Dual syringe CT injection system, Warrendale, PA, USA) beginning with a 66 ml bolus of Iopamidol (370 mg iodine/ml; Niopam 370, Bracco Imaging spa, Milan, Italy) at a rate of 1.2 ml/s, immediately followed by a 34 ml bolus of the same agent at a rate of 2.4 ml/s. CT acquisition of the abdomen and pelvis was initiated 70 seconds after the start of contrast medium injection (LightSpeed VCT; GE Healthcare, Milwaukee, WI, USA) with the following parameters: 120 kV, automated 100–650 mA, and 0.625-mm contiguous sections. The injection regime was adapted from the Baltimore/Geneva group,¹⁰ delivering two-thirds of the total contrast medium volume at an initial slow rate, followed by one-third of the total volume at approximately double the initial rate. A total contrast medium volume of 100 ml was used due to concerns regarding contrast-induced nephropathy.

Image analysis

Axial images of the CT studies acquired with the protocol were reviewed retrospectively in stack mode on a picture archiving and communication system workstation (Centricity PACS, GE healthcare) at our institution. The attenuation value of blood within the transplant pancreas vessels were used as surrogate indicators of the diagnostic quality of the CT studies using the new protocol.

After selecting the axial images that best depict the arterial supply and venous drainage to the transplant pancreas, a circular region of interest (ROIs) with a diameter of at least two-thirds of the vessel diameter was placed within the lumen of a vessel of interest to measure attenuation value of blood within the vessel. This was performed by one radiologist with 7 years of experience in body

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