CLINICAL STUDY

# Effects of Sublingual Glyceryl Trinitrate Administration on the Quality of Preprocedure CT Angiography Performed to Plan Prostate Artery Embolization

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## ABSTRACT

**Purpose:** To determine the effects of sublingual glyceryl trinitrate (GTN) on the quality of planning computed tomography (CT) angiography performed prior to prostate artery embolization (PAE).

**Materials and Methods:** A retrospective cohort study was performed on patients who had previously undergone CT angiography before a procedure for PAE at our institution. Early CT angiography studies for PAE at our single center had initially been performed without GTN. These were compared to subsequent CT angiography studies that had been performed with GTN, after a previously implemented change in practice. Prostate arteries were examined by 2 blinded observers for peak enhancement (Hounsfield units [HU]) and lumen diameter. In addition, assessors' interpretation of the prostate artery origin from CT angiography was compared with the true anatomy demonstrated at the time of procedure.

**Results:** A total of 16 patients, corresponding to 32 prostate arteries, were examined on CT angiography. Mean diameter of the prostate artery was found to be significantly greater in those receiving GTN (2.2 mm vs. 1.6 mm, $P < .001$). Peak prostate artery enhancement was also greater in the GTN group (218 HU vs 173 HU, $P = 0.042$). Observers correctly identified the prostate artery origin more frequently in the GTN group; however, this difference was not statistically significant (56% vs 25%, odds ratio = 3.9, $P = .149$).

**Conclusions:** The administration of sublingual GTN immediately prior to CT angiography is associated with a significant increase in prostate artery diameter and peak opacification. This was not associated with a statistically significant increase in the ability of observers to correctly identify the origin of the prostate artery.

## ABBREVIATIONS

GTN = glyceryl trinitrate, PAE = prostate artery embolization

Prostate artery embolization (PAE) is increasingly used in the treatment of benign prostate hyperplasia, with mounting evidence to support its safety and efficacy (1–5). PAE is, however, a technically demanding procedure, perhaps foremost because of the challenging vascular anatomy of the prostate gland. The prostate arteries are not only small (often 1–2 mm) but are highly variable in their origin and can run a tortuous course. In most instances, the prostate artery takes origin from the internal pudendal artery but is also found arising from common trunks with the superior vesical and obturator arteries, among other combinations, off the internal iliac arteries (6). Accessing the arteries and then confirming catheter position can be time-consuming, particularly to avoid nontarget embolization of organs such as the bladder or rectum. Preprocedural computed tomography (CT) angiography is often performed as part of the workup for patients undergoing PAE to identify the prostate artery origin, number of pedicles, and presence of anastomoses (7).

The use of sublingual glyceryl trinitrate (GTN) is well established in cardiac CT angiography to improve

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assessment of the coronary arteries by increasing vessel diameter and volume (8). GTN is a systemic arterial and venous vasodilator, acting in the form of a prodrug. It rapidly undergoes intracellular metabolism to its eventual active metabolite, nitric oxide, which promotes intracellular cyclic guanosyl monophosphate production to induce smooth muscle relaxation (9). The use of sublingual nitrates as part of a protocol for CT angiography of the prostate arteries has previously been described (10) but without objective evidence of its effects.

The rationale for this study was to investigate whether GTN improved the quality of preprocedural CT angiography for PAE, specifically to examine its effects on prostate artery diameter and opacification and to determine if higher-quality preprocedural imaging improved the ability of readers to correctly identify the prostate artery origin.

## MATERIALS AND METHODS

Ethical approval for this study was granted by the institutional review board. Preprocedural planning CT angiography for PAE had historically been performed at our institution without the use of GTN, but practice had previously been empirically changed to include its administration. Therefore, a retrospective cohort, containing patients who had undergone CT angiography either with or without GTN administration between 2014 and 2015, was available to analyze.

Eight patients who had undergone CT angiography without GTN were identified and compared to the subsequent 8 patients who had undergone CT angiography with GTN. A t-test confirmed that there was no significant age difference between the 2 study groups (mean age = 69 years vs. 66 years, $P = .20$, two-tailed t-test). All patients within the cohort had also undergone multiparametric magnetic resonance imaging (MRI) of the prostate, from which prostate volume had been calculated. No significant difference was observed in prostate volume between study groups (mean = 92 ml vs. 70 ml, $P = .16$, two-tailed t-test). Prostate volumes were calculated from T1-weighted MRI datasets using the prolate ellipsoid method, where volume = length x width x height x .52. All prostate MRIs had been acquired on a 3-Tesla MRI scanner with an axial slice thickness of 3 mm with a 20 x 20 field of view and a 256 x 256 matrix.

Preprocedural CT angiography was performed in all patients using an identical protocol. Images were obtained from the upper poles of the kidneys to the femoral heads. Next, 100 ml of Niopam 370 (Bracco UK Ltd., Wooburn, Bucks, United Kingdom) was administered intravenously, and scanning was performed in the arterial phase, with automatic triggering based on a region of interest defined in the abdominal aorta (SmartPrep function, GE Healthcare, Chicago, Illinois). All images were obtained on the same CT scanner (GE Lightspeed) with a rotation time of .5 s, pitch of .984:1, and automatic kV and mA modulation. A slice thickness of .625 mm was obtained with reconstructions in the axial plane of 1.25 mm and coronal and sagittal plane of 3 mm.

Where sublingual GTN was administered, this consisted of 2 puffs from a metered dose device (Glytrin 400, Ayrton Saunders Ltd., Runcor, Cheshire, United Kingdom) constituting a total dose of .8 mg. This was administered on the scanner table, immediately prior to imaging (2–4 minute delay to image acquisition), with blood pressure, pulse, and saturation monitoring. Prior to administration, all patients were screened for sensitivity/allergy to GTN and possible contraindications and had their resting blood pressure recorded. Contraindications to GTN administration included but were not limited to: hypotension and hypervolemia, aortic or mitral stenosis, hypertrophic cardiomyopathy, and profound anemia (11). It should be noted that peak plasma concentrations of GTN are reached within 4 minutes of sublingual administration, with a half-life of 1–3 minutes (12).

Computed tomography (CT) angiograms were read by 2 radiologists, each with over 10 years' experience in CT angiography interpretation. Observers analyzed images independently and were blinded to patient details, including to whether GTN had been administered. Observers recorded the anatomy of the origin of the prostate artery, both written and schematically. This was compared against the true intraprocedural anatomy that had been previously determined by a combination of angiography and cone-beam CT by the procedure operator. Only if both observers correctly identified the prostate artery origin was this recorded as being able to correctly identify the origin for the purposes of the analysis. Two blinded observers also made independent measurements of prostate artery lumen diameter and peak vessel opacification. The mean of the values from the 2 observers was taken as the final value for analysis.

Initial image analysis was performed on a diagnostic grade workstation, with images viewed via Insight PACS (Version 8.2.12.1, Insignia Medical Systems, Basingstoke, United Kingdom). Measurements of prostate artery lumen diameter and peak opacification were performed using TeraRecon Aquarius iNtuition (TeraRecon 4000 Foster City, California).

Prostate artery lumen diameter was measured on the 1.25 mm axial images, at the point closest to the vessel origin that allowed clear measurement of vessel diameter (i.e., where the vessel was not abutting other vessels or high attenuation structures and was not running obliquely). In all cases, this was within 1 cm of the origin—this was deemed representative, since where curved planar reconstructions of the vessel could be performed, very little variation in vessel diameter occurred within the first centimeter. The mean lumen diameter was taken from 2 orthogonal diameter measurements using the "Profile" function in the TeraRecon software (**Fig 1**). This function creates an attenuation profile through a drawn line and can define points where attenuation reaches 3 standard deviations below the mean. These are taken as the lumen wall to obtain a reproducible diameter measurement even in very small vessels. A similar method was previously described for the assessment of coronary artery diameter measurements in this context (13). Peak lumen opacification values were also obtained from the same 2 vessel profiles, and the mean of the 2 measurements was recorded.