

Influence of Nitroglycerin for Combined Coronary Lumen and Vessel Wall Magnetic Resonance Imaging

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Background

Sublingual nitroglycerin (NTG) has been recently shown to improve subjective image quality for coronary magnetic resonance angiography (CMRA) without influencing signal-to-noise or contrast-to-noise ratios.¹ The purpose of the study was to investigate the influence of sublingual NTG on coronary lumen and vessel wall imaging using the combined, single sequence, i-T2prep.

Introduction

The pharmacodynamics of NTG suggests that blood levels are barely detectable 20 minutes after sublingual administration.² This means that it is impractical to utilize effects for both coronary lumen and vessel wall imaging. Therefore, we used a coronary vessel wall sequence based on the acquisition and weighted subtraction of two 3D coronary steady-state free-precession (SSFP) data sets, one obtained with a T2 preparation prepulse (T2prep-ON) and the second without (T2prep-OFF). This allows for nulling of the signal of arterial blood while maintaining the signal of myocardium and the vessel wall. The two acquisitions are interleaved over 2 heartbeats. The resulting sequence (i-T2prep) is ideal for the purposes of our study allowing identical influence of NTG on both CMRA (using the acquisition with T2prep-ON) and vessel wall (using the i-T2prep weighted subtraction). Additionally, this single sequence can be completed within the time frame of action of sublingual NTG.

Methods

i-T2prep MRI was performed before and directly after administration of 800 micrograms of sublingual NTG. A 1.5 Tesla (T) Achieva clinical MR scanner (Philips Healthcare, Best, NL) equipped with a 32-element cardiac phased-array receiver coil was used. The mid-diastolic rest period, ascertained from 4-chamber cine images, was used to define the trigger delay and acquisition window. RCA geometry was used for the ECG-triggered and navigator-gated i-T2prep sequence. Imaging parameters included flip angle = 70°; TE/TR = 2.7/5.4 ms; acquired matrix = 280x280; slice thickness = 2 mm; 20 slices acquired and acquired in-plane resolution = 1x1 mm. A diaphragmatic 1D respiratory navigator and a fat suppression pre-pulse preceded the imaging sequence. The i-T2prep sequence was repeated, starting exactly 1 minute and 45 seconds after the administration of 800 micrograms of sublingual NTG. Vessel wall images were obtained by subtraction of T2prep-ON from T2prep-OFF images. A multiplication factor of 1.8 was used for T2prep-ON images to achieve consistent blood signal subtraction. For quantitative analysis, RCA lumen and vessel wall images were reformatted along its major axis and analyzed using "Soap-Bubble" software (Philips Healthcare, Best, NL). The length visualized, proximal diameter, and sharpness were measured for both lumen and vessel wall. Two readers also undertook a qualitative analysis by means of a consensus reading. The following scoring system was used: 0=not visible; 1=markedly blurred borders; 2=moderately blurred borders; 3=mildly blurred borders and 4=sharply defined. A simplified system was used for vessel wall images (1=not visible; 2=partly visible; 3=entirely visible but not sharp; 4=entirely visible and sharp).

Results

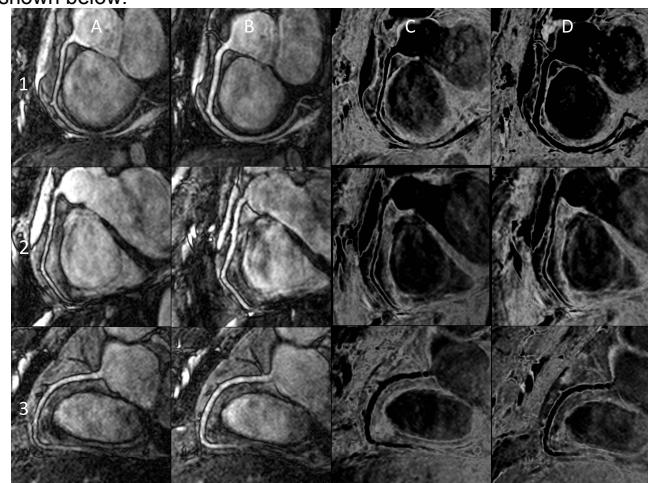
Ten subjects (5 male) successfully participated in the study without any adverse events. Mean age was 38.7 ± 6.8 years. Mean vessel wall thickness with GTN was almost identical to previously published MRI black-blood values for healthy individuals (1.0 ± 0.2 mm using i-T2prep and 1.0 ± 0.2 mm for previous black-blood sequence).³ Sample images are shown below.

Table 1. Normally distributed variables (mean \pm s.d.) tested using 2-tailed paired t-tests. * denotes significant differences ($p < 0.05$).

Measure	Rest	NTG	p
Lumen Sharpness (%)	47 ± 9	45 ± 12	0.333
Lumen Length (cm)	9.8 ± 2.6	11.4 ± 3.3	0.025*
Lumen Diameter (mm)	2.16 ± 0.32	2.52 ± 0.59	0.036*
Wall Sharpness (%)	24.9 ± 14.2	27.4 ± 15.3	0.039*
Wall Length (cm)	9.8 ± 4.1	10.4 ± 3.4	0.412
Wall Diameter (mm)	1.07 ± 0.27	1.02 ± 0.23	0.253

Table 2. Table shows Categorical Variables (median (interquartile range)). P-values are given for paired differences using Wilcoxon Signed Ranks Test. *denotes a significant difference ($p < 0.05$).

Measure	Rest	NTG	p
Lumen IQ	3.0 (2 to 3.25)	3.0 (3 to 4)	0.046*
Wall IQ	2.0 (2 to 3.25)	3.0 (2 to 4)	0.3



Rows 1 to 3 represent individual volunteers. Column A represents RCA lumen CMRA. Column B is the repeated lumen CMRA using NTG. Column C represents subtraction RCA vessel wall images. Column D represents the repeat subtraction image using NTG.

Conclusion: We were able to show a mean increase in vessel diameter of 16.7% using NTG. We believe that this was responsible for greater image quality and visualized length of RCA lumen. It also results in improved vessel wall sharpness. Hence, NTG improves both coronary lumen and vessel wall imaging when using the combined sequence, i-T2prep. The methodology described here has great potential for future pathophysiological studies of coronary artery disease.

References: 1. Jin H et al. AJR. 2010. 2. Armstrong PW et al Circulation. 1979 3. Kim WY et al Circulation. 2002