Intimal thickness determines the detection of non-calcified plaques by computed tomography angiography

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Alina van der Giessen, Frank Gijsen, Udo Hoffmann

cardiovascular biomechanics

Aim

To study the ability of computed tomography angiography (CTA) to detect atherosclerotic plaque as compared to intravascular ultrasound (IVUS) in an ex-vivo setting and determine a size threshold for non-calcified plaques.

Methods

Ten ex-vivo human athero-sclerotic coronary arteries were imaged in a moving phantom by Dual Source CT (Siemens Medical Solutions) (DSCT) and IVUS (Boston Scientific). Cross-sectional images were reconstructed and co-registered every 0.4 mm and assessed qualitatively for the presence and compo-sition of atherosclerotic plaque (non-calcified, mixed and calcified plaques) on DSCT and IVUS. In addition, lumen area, plaque area, plaque eccentricity and intimal thick-ness was measured on the IVUS images.

Results

All plaque types: 1002 cross-sections were assessed by IVUS containing 58% non-calcified, 16% mixed, and 3% calcified plaque (fig. 1). The cross-table 1 and table 2 show higher accuracies for mixed and calcified plaques (82% and 92%) than for non-calcified plaques (69%, p<0.05) for the detection by CTA. An example of the IVUS and CTA assessment of one artery is shown in figure 2.

Table 1: Classification of plaques on CTA compared to IVUS.

	IVUS	No plaque	Non-calcified	Mixed	Calcified	Total
CTA						
No plaque		**204**	181	6	0	391
Non-calcified		10	**336**	54	1	401
Mixed		7	51	**52**	13	123
Calcified		2	17	50	**18**	87
Total		223	585	162	32	1002

Figure 1: Examples of the plaque types on IVUS and CTA. Arrows point at calcifications, stars are in non-calcified plaque tissue.

Table 2: Ability of CTA to detect and classify plaque.

	IVUS plaque type				
	Any	Non-calcified	Mixed	Calcified	Mixed/ Calcified
Sensitivity	76	57	32	56	69
Specificity	91	84	92	93	90
Accuracy	79	**69**	**82**	**92**	86
Prevelance	78	58	16	3	19

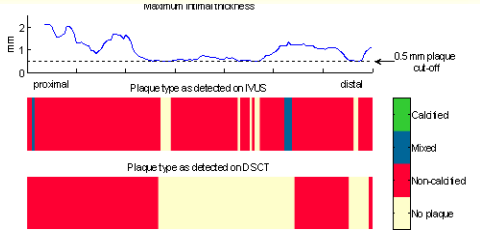

Figure 2: Example of classification of plaques on IVUS and CTA for 1 artery with abundant non-calcified plaque of different sizes.

Table 3: IVUS measures compared for non-calcified plaques.

IVUS measures	Lumen area	Wall area	Plaque area	Intimal thickness	Eccen-tricity
	mm²	*mm²*	*mm²*	*mm*	-
Detected by CTA	8.3	17.6	9.3	**0.73**	4.4
Not detected by CTA	9.4*	15.2	5.8*	**0.47***	3.1*

*significantly different (p<0.05)

Non-calcified: Table 3 shows the influence of IVUS measures on the detection of non-calcified plaques by CTA. Multivariate regression analysis showed that intimal thickness was the strongest independent predictor for the detection of non-calcified plaque by CTA (OR 1.55/0.1 mm). The thicker the plaque, the better the detection by CTA (fig. 3).

Conclusion

We established intimal thickness as an independent predictor of the ability of CTA to detect non-calcified plaque as compared to IVUS in an ex vivo setting. A reasonable detection rate (80%) was found for plaques with an intimal thickness of > 0.78 mm.

Relevance

Given knowledge from IVUS studies about the prevalence of plaques in various patient populations, these results provide a perspective for the ability of CTA to assist risk prediction and to assess plaque progression over time.

Figure 3: Effect of intimal thickness on the detection of non-calcified plaques by CTA.