

## The CTTO registry: is the CT really necessary?

Carlo di Mario\*, MD, PhD, FESC, FACC; Neville Kukreja, MA, MRCP

Royal Brompton Hospital, London, United Kingdom

*This editorial refers to García-García et al, Computed Tomography in Total Coronary Occlusions (CTTO Registry): radiation exposure and predictors of successful percutaneous intervention.*

The introduction of stiff and steerable wires and the miniaturisation of superflexible high profile over-the-wire microcatheters has dramatically changed the scene of the chronic total occlusion (CTO) treatment. The frustrating experience of being unable to penetrate a stiff occlusion cap or of being unable to steer the wire in the direction required belongs to the past, together with the extreme disappointment of the failure to cross the occlusion with a balloon once the wire has reached the distal true lumen. A combined antegrade and retrograde approach via collaterals facilitates recanalisation in the most stubborn occlusions and the correct identification of the intraluminal position of the wire after crossing is allowed by the more frequent use of a bilateral approach with double injection<sup>1</sup>. The missing tile of the puzzle and the reason why 20-30% of occlusions are still unsuccessful is the inability to identify the path of the vessel in the occluded segment, the main cause of failure if the occluded segment is long and tortuous. The parallel wire technique, retrograde recanalisation, CART (controlled antegrade and retrograde tracking) and STAR (subintimal tracking and recanalisation) are all techniques designed to rescue an initial subintimal wire position and bail-out the interventionalist<sup>2,3</sup>. Nevertheless, CTO's remain a technical challenge for interventional cardiologists: when compared to other lesion subsets, the success rates remain lower and the procedural duration longer despite the availability of a number of dedicated wires, devices and techniques. Even successful procedures require too much time, too much radiation exposure to the operators and patient, too many stents to cover the occlusion and long distal dissections and carry the risk, like the STAR technique, of covering many side-branches which induces myonecrosis and generates a low flow status at high risk of re-occlusion even after drug eluting stent implantation.

So, can we do anything further to increase our chances of success and reduce the procedure times? Computed tomography (CT) offers many potential tools to solve these problems since the soft tissue or calcium of the occluded segment can be followed along the

occluded segment, while the three dimensional nature of CT allows assessment of the reconstructed silhouette in all the desired angiographic planes. Advances in software technology allows co-registration of multimodality imaging so that 3D images of the occluded segment can be accurately analysed, reconstructed and then superimposed onto the conventional angiographic images in the catheter laboratory.

Nevertheless, the paper by Garcia-Garcia et al<sup>4</sup> in this issue of EuroIntervention raises more questions than it answers, since despite the detailed anatomical information provided by CT angiography coupled with a wide range of specialised wires and devices and highly experienced operators, the overall success rates in this registry remains relatively low at 62.7%. This raises the question of whether we should be using CT angiography as a routine part of the preprocedural assessment for patients who will undergo lengthy procedures with significant radiation exposure. The authors found that the mean effective radiation dose of the PCI was 39.3 mSv with an additional mean effective radiation dose of 22.4 mSv for the CT scan, i.e. a total of 61.7 mSv, which is a 20-fold increase on annual background radiation and the equivalent of 3000 chest X-rays<sup>5</sup>. Is this exposure excessive? Effective radiation doses are commonly quoted, but it is important to realise that organ equivalent doses differ from the effective dose – the thymus gland, breast and lung receive higher doses<sup>6</sup>. The lifetime attributable risk (LAR) of cancer resulting from a 64-slice coronary CT has been estimated at 0.22% for a 60 year-old female and 0.081% for a 60-year old female. The LAR is lower in males and in older patients: fortunately, not many young females have CTO's but these young patients are at highest risk of iatrogenic cancer: for example the 0.7% LAR for a 20-year old female is clearly significant and is not dissimilar to the periprocedural risks associated with invasive diagnostic coronary angiography.

One of the drawbacks of any registry of CTO's is the limited number of patients. This may explain the surprising finding that patients with

\* Corresponding author: Royal Brompton Hospital, Sydney Street, London SW3 6NP, United Kingdom

E-mail: C.DiMario@rbht.nhs.uk

bridging collaterals more often had a higher success rate (bridging collaterals were present in 59.5% of successful cases vs. 43.4% of unsuccessful cases,  $p=0.04$ ). In this current registry, a further limitation is the use of a variety of CT systems, ranging from 16-slice up to 64-slice dual source, since different scanners have different effective radiation doses. Although 64 slice scanners have higher sensitivity and specificity when compared to 16- or 4-slice scanners, they also significantly increase radiation exposure from 5-8 mSv in a 4-slice scanner up to 15-20 mSv with a 64-slice scanner<sup>7</sup>. However, a recent report on effective dose in coronary angiography performed by dual source CT found mean values of 7.8–8.8 mSv and found that radiation dose decreased with increasing heart rate<sup>8</sup>. For comparison, conventional invasive coronary angiography conveys an effective dose of approximately 5.7 mSv<sup>9</sup>. The latest generation of scanners currently under evaluation promise to reduce the radiation exposure even further: the effective dose with 256 slice CT is approximately 38% and 49% lower than for 16- and 64 slice scanners<sup>10</sup> and the radiation dose from a 320-slice scanner is only 6.8mSv<sup>11</sup>.

Ultimately, the main question is whether the benefits of multislice CT (MSCT) outweigh the risks and costs. Garcia-Garcia et al highlight the limitations of conventional angiography in the assessment of coronary artery calcification and found that the only independent predictor of success was calcification >50% of the cross-sectional area when measured by MSCT. This finding differs slightly from a previous report by the same group, which suggested that a blunt stump (by conventional angiography), occlusion length >15 mm, and severe calcification (by 16-slice CT) were independent predictors of procedural failure<sup>12</sup>.

Nonetheless, it does seem logical that patients with excessive calcification would have lower success rates. If this is the only useful predictive information provided by MSCT, the next question is which type of scanner is the most appropriate for pre-procedural CTO assessment? These patients have already undergone conventional angiography and their diagnosis is already known. If the degree of calcification is the most important information derived from the CT scan, then maybe a lower resolution scan with corresponding lower radiation dose is adequate. Ideally, the value of MSCT in this setting is best answered with a randomised trial comparing procedural success and clinical outcomes in patients undergoing preprocedural CT angiography versus no CT or simpler calcium scoring. Unfortunately, such a trial will always be limited by the relatively low numbers of patients treated percutaneously for CTO's. Perhaps further assessment of the role of CT angiography in these patients should be delayed until more advanced scanners with lower radiation doses are available. If MSCT scanning can improve our chances of technical success (or can indicate which patients should not undergo PCI due to a very low chance of success), then preprocedural lower radiation imaging may have a role in the future. Nevertheless, patients undergoing MSCT assessment of CTOs should be advised about the excessive total radiation exposure and increased lifetime risk of cancer before this route is taken.

## References

1. Sianos G, Barlis P, Di Mario C, Papafaklis MI, Büttner J, Galassi AR, Schofer J, Werner G, Lefevre T, Louvard Y, Serruys PW, Reifart N; EuroCTO Club. European experience with the retrograde approach for the recanalisation of coronary artery chronic total occlusions. A report on behalf of the euroCTO club. *EuroInterv*. 2008;4:84-92.
2. Di Mario C, Werner G, Sianos G, Galassi A, Büttner J, Dudek D, Chevalier B, Lefèvre T, Schofer J, Koolen J, Sievert H, Reimers B, Fajadet J, Colombo A, Gershlick A, Serruys P.W, Reifart N, the EuroCTO Club for European perspective in the recanalisation of Chronic Total Occlusions (CTO): consensus document from the EuroCTO Club. *EuroInterv*. 2007;3:30-43.
3. Garcia-García HM, Kukreja N, Daemen J, Tanimoto, van Mieghem CAG, Gonzalo N, van Weenen S, van der Ent M, Sianos G, de Feyter PJ, Serruys PW. Contemporary treatment of patients with chronic total occlusion: critical appraisal of different state-of-the-art techniques and devices. *EuroInterv*. 2007;3:188-196.
4. Garcia-García HM, van Mieghem CAG, Nieves Gonzalo N, Meijboom WB, Weustink AC, Onuma Y, Mollet NR, Schultz CJ, Meliga E, van der Ent M, Sianos G, Goedhart D, den Boer A, de Feyter PJ, Serruys PWS. Computed Tomography in Total Coronary Occlusions (CTTO Registry): radiation exposure and predictors of successful percutaneous intervention. *EuroInterv* 2009;4:607-616.
5. Einstein AJ, Moser KW, Thompson RC, Cerqueira MD, Henzlova MJ. Radiation dose to patients from cardiac diagnostic imaging. *Circulation* 2007;116:1290-305.
5. Einstein AJ, Henzlova MJ, Rajagopalan S. Estimating risk of cancer associated with radiation exposure from 64-slice computed tomography coronary angiography. *JAMA* 2007;298:317-23.
6. Pugliese F, Mollet NR, Hunink MG, Cademartiri F, Nieman K, van Domburg RT, Meijboom WB, Van Mieghem C, Weustink AC, Dijkshoorn ML, de Feyter PJ, Krestin GP. Diagnostic performance of coronary CT angiography by using different generations of multisection scanners: single-center experience. *Radiology* 2008;246:384-93.
7. Stolzmann P, Scheffel H, Schertler T, Frauenfelder T, Leschka S, Husmann L, Flohr TG, Marincek B, Kaufmann PA, Alkadhi H. Radiation dose estimates in dual-source computed tomography coronary angiography. *Eur Radiol* 2008;18:592-9.
8. Coles DR, Smail MA, Negus IS, et al. Comparison of radiation doses from multislice computed tomography coronary angiography and conventional diagnostic angiography. *J Am Coll Cardiol* 2006;47:1840-5.
9. Mori S, Nishizawa K, Kondo C, Ohno M, Akahane K, Endo M. Effective doses in subjects undergoing computed tomography cardiac imaging with the 256-multislice CT scanner. *Eur J Radiol* 2008;65:442-8.
10. Rybicki FJ, Otero HJ, Steigner ML, Vorobiof G, Nallamshetty L, Mitsouras D, Ersoy H, Mather RT, Judy PF, Cai T, Coyner K, Schultz K, Whitmore AG, Di Carli MF. Initial evaluation of coronary images from 320-detector row computed tomography. *Int J Cardiovasc Imaging* 2008;24:535-46.
11. Mollet NR, Hoyer A, Lemos PA, Cademartiri F, Sianos G, McFadden EP, Krestin GP, Serruys PW, de Feyter PJ. Value of preprocedure multislice computed tomographic coronary angiography to predict the outcome of percutaneous recanalization of chronic total occlusions. *Am J Cardiol* 2005;95:240-3.