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Editorial

Pre-procedural computed tomography in transcatheter pulmonary valve replacement: The first steps towards standardization of image quality

Transcatheter pulmonary valve replacement (TPVR) is a novel therapy and offers an interesting alternative for open heart surgery in patients with significant pulmonary stenosis or regurgitation of the right ventricle outflow tract (RVOT). Most patients referred for TPVR are very young, suffer from congenital heart disease and typically have undergone multiple previous surgeries [1]. The highly variable anatomy, compliance and distensibility of the RVOT, in addition to the location of adjacent vascular structures are important factors influencing the outcome of TPVR. Similar to transaortic valve implantation (TAVI), pre-procedural computed tomography (CT) may play an important role in evaluating various important variables prior to TPVR.

Thoraco-abdominal CT angiography (CTA) may reveal relevant comorbidities that could complicate the procedure. As is the case in TAVI, technical success of TPVR requires accurate prosthesis sizing, since incorrect sizing can cause device embolization or paravalvular regurgitation [2]. In addition to this, CTA could predict the suitability of possible percutaneous access routes described in the literature, including the transfemoral, transjugular and subclavian route. Vessel diameter can be narrow and therefore might not be suitable in very young patients [3]. Until now, studies investigating pre-procedural planning for this relatively new procedure are very few and mostly lack a clear description of specific imaging protocols. In this issue of the International Journal of Cardiology; Heart & Vasculature, Curran and colleagues aimed to define relevant CT measurements that could predict valve implant size and patient suitability for TPVR [4].

The authors retrospectively evaluated RVOT measurements on 18 pre-operative CT scans and correlated these to the sizes of the implanted valves. They used post-processing software for multiplanar reconstruction and measurements in the RVOT plane. Several RVOT measurements were evaluated, of which the derived circumference (D_{circ}) showed a significant agreement and the derived area (D_{area}) showed adequate agreement with implanted valve sizes. Furthermore, D_{area} proved a reliable predictor in cases where the RVOT was too large to proceed safely with TPVR. The authors concluded that pre-interventional valvular prosthesis sizing in patients using CT imaging could lead to the selection of patients who (anatomically) can be scheduled for TPVR, without the need for invasive catheter-based balloon measurements [4].

Curran and colleagues describe a new and relevant topic and are among the first to demonstrate that CT measurements of D_{circ} and D_{area} and diameter of the RVOT provide valuable information regarding patient suitability for TPVR and prediction of transcatheter valve size. One limitation that requires consideration is the variability of scan techniques and contrast media injection protocols. The included scans are acquired with diverse acquisition modes (with or without ECG gating or triggering), scan parameters (e.g. pitch, field of view, reconstruction kernels and slice thickness) and contrast timing.

Both acquisition parameters and various reconstruction settings have been studied extensively in the TAVI population in order to optimize selection of the most appropriate prosthesis size [5–7]. It is recommended to perform a retrospectively ECG-gated CTA of the heart; the high spatial and temporal resolution allows dedicated post-processing software to reconstruct images along predefined planes. The complete vasculature can be visualized three-dimensionally, providing all information for interactive planning of the most appropriate pathway [8]. Previous research indicated that the aortic annulus morphology and size can vary significantly during the cardiac cycle. Perimeter- and surface area-based measurements have proven more reliable than aortic valve and annulus diameters alone [9]. Similar morphological changes for the RVOT have also been demonstrated [10]. Schievano et al underlined the importance of ECG-gated CTA to standardize RVOT measurements as these patients frequently present with a history of cardiac surgery, altering the anatomy of the RVOT and the pulmonary valve [10]. Very few studies outline the importance of using appropriate scan techniques in pre-interventional CT protocols in TPVR. However, Gillespie and colleagues do suggest measurements for 'landing zone' length in both the end-systole and end-diastole, stressing the importance of using ECG-gated CT scans [11].

Most patients scheduled for TPVR have a history of congenital cardiac disease and a replacement is often necessary at a relatively young age to overcome dysfunction of the pulmonary valve [1]. Therefore, it is vital to keep radiation dose as low as reasonably achievable (ALARA principle), something that might be less relevant in an older patient population (e.g. TAVI population). Reducing the volume of injected contrast media is likely of lesser importance, since this younger population is expected to have adequate renal function. Therefore, the contrast media bolus timing and volume should be optimized to answer any important anatomical questions.

A dedicated ECG-gated CTA protocol, with optimized scan, reconstruction and contrast media parameters should be used for imaging of the RVOT in the work-up for TPVR. Future research should focus on finding the optimal imaging time point within

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the cardiac cycle to optimize RVOT measurements, describing the 'landing-zone' and to further define the most reproducible and reliable measurements for prosthesis sizing in this specific patient group. In order to get comparable measurements, which may in the future be performed by (semi-) automatic software, standardization of CT technique and image quality is the key for the work-up of TPVR.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcha.2020.100542.

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