The legend tells that William Tell, an extremely accurate archer, lived in Bürglen, Switzerland, around the 14th century. As a punishment for an act of rebellion, he was forced by the governor to shoot an arrow against an apple placed on his son’s head. If he hit the target, he would be released. If he failed, he would be sentenced to death. William only needed an arrow to succeed, but had hidden a second one only visible to few witnesses. When inquired about that second arrow, he replied that, had the first one gone off target, he would have shot the second directly to the governor’s heart.

Ageing is a fact, and medicine must adapt itself to it to satisfy the requirements of an elderly population. Aortic stenosis is a frequent problem in this group of patients, appearing predominantly in individuals over 75 years of age. Transcatheter aortic valve implantation (TAVI) has become the treatment of choice for patients with high surgical risk or considered inoperable.

One of the key aspects before selecting a prosthetic aortic valve to be implanted percutaneously is accurate aortic annulus definition to decide the model and sizing. Historically, first approaches to this essential step were done through transthoracic echocardiography (TTE), parasternal long-axis plane. Shortly after, TEE soon showed to be superior, leading to better outcomes and fewer complications than TTE. Both techniques are, however, hindered by a common limitation: the 2D evaluation of a 3D structure. The aortic annulus, where the aortic valve lies, represents a transitional area between the left ventricular outflow tract and the aorta. Because of its frequently elliptical shape, 2D imaging often underestimates its dimensions as they measure the diameter in a single plane. Consequently, to overcome this limitation, we should resort to 3D imaging techniques to appropriately define and measure the aortic root.

The main advantages of MSCT are its low intra-observer and inter-observer variability and the additional information it provides, such as the distance between the valve plane and the origin of the coronary arteries, dimensions of the aortic root, and the presence, severity, and extent of valve calcification, which has shown to predict the incidence of paravalvular regurgitation after TAVI. Moreover, MSCT is able to determine the angle of the valve plane correlated to that of the fluoroscopic projections used during valve implantation, a factor that can reduce the use of radiation during the procedure. The main limitations of MSCT are the use of radiation and iodinated contrast. One of the main limitations of 3D-TEE is the variability in repeated measurements. To solve this, the 3D system automatically configures a geometric model of the aortic root from the images obtained by 3D-TEE and performs a quantitative analysis of these structures. This allows modelling and quantifying the aortic root from 3D-TEE data with high reproducibility. These techniques have shown good correlation with other 3D-based validated techniques, with results supporting its use in clinical practice as an alternative to MSCT prior to TAVI procedures.

When confronted with the decision of choosing prosthetic size, a wrong decision can lead to multiple complications. Accurate determination of aortic annular diameters is of paramount importance at this step. Prosthesis smaller than required implies high risk of non-trivial aortic regurgitation and could even lead to valve migration following implantation. On the other hand, oversized prosthesis can cause different degrees of atrio-ventricular conduction disturbance and often leads to the need for a permanent pacemaker.

Aortic regurgitation is a frequent complication after TAVI and has shown to negatively impact patients’ outcome, being the main predictor of mortality. This problem has become one of the main drawbacks of TAVI, and therefore, accurate prosthetic sizing through pre-procedural imaging has been, and still is, a key element in TAVI-related research. This is particularly relevant given the fact that during the procedure, the operator has no direct view of the aortic root.

The question now is whether 3D-TEE plays a role in patient selection for TAVI, especially in annulus sizing and assessment of aortic root morphology, including measurement of the distance between the annulus and coronary ostia. In their study, Vaquerizo and collaborators compared 3D-TEE with MSCT for pre-procedural TAVI sizing. Their results showed that 3D-TEE measurements of diameter, perimeter, and area were highly correlated with the measures obtained from MSCT, although the results from 3D-TEE were significantly smaller. However, absolute values of aortic annulus perimeter between MSCT and 3D-TEE sizing showed significant
discrepancies in more than half of the study population. Having a larger aortic annulus was the only independent predictor of increased difference in mean annular perimeter determinations between 3D-TEE and MSCT. The shocking clinical consequence of this result is that up to 50% of patients would have received a different valve size according to manufacturer-recommended, area-derived sizing algorithms based on 3D-TEE perimeter annular measurements. These findings may be attributed to the lower spatial resolution of 3D-TEE volumetric imaging. Besides, measurements were carried out by two different operators and with software heavily relying on manual measurements. This adds to previous evidence pointing to the imperative need of standardized protocols to accurately locate annular plane and avoid ultrasound artefacts. Several technical difficulties complicate 3D-TEE measurements. Among them, a major limitation is the impossibility to directly trace the aortic annulus from 3D short-axis images, since minor deviations may result in significant changes in perimeter and area measurements. Additionally, partial acoustic shadowing of the annulus, ectopic calcification, and acoustic artefacts (side lobes) may mislead the measurement and induce significant errors.

Vaquerizo and collaborators recommend the use of 3D-TEE as an alternative when MSCT is not available or contraindicated. However, in previous studies, Husser and collaborators reported 3D-TEE measurements of the aortic annulus diameters and areas yielding smaller values with the exception of the sagittal diameter, which showed excellent agreement with MSCT measurements. Accordingly, Husser et al.7 concluded that using sagittal diameters, 3D-TEE and MSCT were able to predict well the final prosthesis size.

Currently, it seems evident that MSCT is the gold standard for aortic annulus sizing before TAVI. Nevertheless, the usefulness of the 3D-TEE in pre-procedural sizing is continuously evolving and extends beyond playing an important role in intra-procedural guidance. The challenge for these software innovations is to provide results comparable to those obtained by MSCT. Some major advances have already been introduced, such as the enhancement of adjacent structures, such as the septum and anterior mitral leaflet. One interesting study, recently published by Garcia-Martin and collaborators, compares the aortic annulus measurements using a new automatic software for 3D-TEE and MSCT in candidates to TAVI, to assess its reproducibility. The new automatic 3D-TEE software quantified the aortic root from 3D-TEE data with high reproducibility compared with MSCT,10 supporting its use in clinical practice. Through these improvements, we can expect 3D-TEE to progressively add more and more valuable information, which may complement that obtained by MSTC before TAVI. It will be interesting to see the results of further studies.

So, going back to our famous archer, we believe William Tell would advise us to trust our MSCT accuracy while keeping a second 3D-TEE arrow to give us alternative options. Both accuracy today and advancement in future options are important, but safety is essential.

Conflict of interest: None declared.

References