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EDITORIAL

HALT – an evolving understanding of the mechanisms of formation and clinical relevance

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Since its initial description in 2015[1], hypoattenuating leaflet thickening (HALT) has been the subject of ongoing research. The incidence of HALT has been reported among all commonly used transcatheter heart valves (THVs) and various surgical bioprosthetic valves, based on data from nested registries of randomised trials as well as prospective and retrospective registries[2]. Its clinical significance is still under investigation. While the relationship of HALT with stroke and mortality is an area of question[3,4], there is growing evidence that HALT is associated with higher valve gradients and earlier valve degeneration[5,6]. Potential mechanisms of HALT development have been proposed, ranging from reduction of neosinus flow, asymmetric valve expansion, and biological mechanisms such as endothelial dysfunction[6]. Recognising this, it is generally accepted that valve design plays a potential role, and it is crucial not to assume that the incidence and mechanisms are the same across valve platforms[6].

Despite advancements in knowledge, there remain outstanding questions.

In this issue of EuroIntervention, Ishizu et al[7] look to provide answers. The authors took a subset of the OCEAN-TAVI registry to investigate the incidence, predictors, and clinical impact of HALT following transcatheter aortic valve implantation (TAVI) with the latest generation of the short frame, intra-annular and balloon-expandable SAPIEN 3 valve, the SAPIEN 3 Ultra RESILIA (S3UR; Edwards Lifesciences). This study is particularly important given the unique design of the S3UR valve with anticalcification treatment of the leaflets and modification of the commissural leaflet suspension method for the smaller-sized valves.

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The authors are commended for their thorough analysis. In addition to assessing HALT according to Valve Academic Research Consortium (VARC)-3 criteria[8], the study's independent core laboratory used four-dimensional cardiac computed tomography (CT) data acquired at 30 days to analyse THV geometry. This encompassed a host of thoughtfully defined variables including oversizing, expansion, canting, alignment, eccentricity, deformation index, and leaflet expansion. The analysis yielded noteworthy results.

The incidence of HALT in this study population was 21.3%, which is similar to prior reports for SAPIEN 3 valves[9]. Unique, though, to this analysis is the exploration of the relationship between HALT and the revised commissural leaflet suspension dedicated to the 20 mm and 23 mm THVs. Notably, these modifications were not associated with a signal for HALT, with a comparable incidence between THV sizes ≤23 mm and ≥26 mm (22.1% vs 20.2%).

Haemodynamic alterations were also assessed. The presence or absence of HALT did not show a significant association with increased gradients, consistent with findings from prior studies[9]. This relationship changed when assessing HALT according to severity. HALT when stratified by a 25% cutoff, by a 50% cutoff, and by involvement of more than one leaflet was significantly associated with higher post-implant gradients. HALT should therefore be considered along a spectrum of severity, rather than as a binary diagnosis.

The authors highlight that cross-sectional measures of valve deformation index and asymmetrical leaflet expansion were the two geometric variables independently associated with a higher incidence of HALT. A high deformation index indicates underexpansion and corresponds to the hourglass-shaped stent frame, while leaflet asymmetricity represents both underexpansion and uneven expansion[5]. Previous

studies also identified these variables as independent predictors of HALT in both balloon-expandable and self-expanding valves[9].

While providing valuable analyses, this study, like all such reports, leaves lingering questions. To start, the authors simply present 30-day data. Evaluating data out to one year and beyond would be valuable, and we hope the authors will pursue longer-term outcomes, including haemodynamic changes, survival, and treatment response. Also, although RESILIA leaflets did not prevent short-term HALT, this anticalcification technology may still be relevant to durability. Longer-term echocardiographic and CT data will demonstrate whether the S3UR reduces the incidence of valve degeneration. It would be good to explore this going forward, and it is helpful to provide evidence that supports and directs technological advancements.

Interestingly the authors opine that in patients with adverse root features and challenging sizing which would behove post-balloon dilatation, a supra-annular self-expanding valve might make more sense. The authors propose that underfilling would be associated with deformation and underexpansion and, in turn, HALT and therefore inform the recommendation for a different valve platform. While this is an intriguing idea, several variables must be considered, and further study is needed before making a confident recommendation.

In closing, we thank the authors for their thoughtful, involved, and important analysis. It represents the first investigation of HALT related to the RESILIA technology and the commissural modification in smaller S3UR valves. The findings overall align with prior such analyses of different valve platforms. While incremental and needed, we would advocate that the authors build on this work and continue this journey by undertaking intermediate and long-term analysis. This will inform the durability of the S3UR valve but also address unresolved issues regarding the relationship of HALT with long-term outcomes and valve degeneration.

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Conflict of interest statement

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