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CONTEMPORARY SCIENTIFIC TRENDS IN MITRAL VALVE EVALUATION FOR TRANSCATHETER MITRAL VALVE REPLACEMENT PLANNING BY COMPUTED TOMOGRAPHY

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Mitral regurgitation is one of the most common valvular diseases in aging populations, and the structural complexity of the mitral valve together with the heterogeneity of regurgitation mechanisms necessitates precise multimodality imaging. While echocardiography remains the first-line modality, computed tomography has become essential for pre-procedural evaluation in transcatheter mitral valve replacement, offering accurate annular measurements, detailed subvalvular assessment, and prediction of the neo-left ventricular outflow tract. This review summarizes current evidence on the role of CT in anatomical assessment of the mitral valve and transcatheter mitral valve replacement planning, incorporating methodological frameworks developed by leading structural imaging groups, including approaches to saddle-shaped versus D-shaped annular modeling, dynamic annular behavior, and device-specific considerations. CT provides high spatial resolution and reproducibility, and further standardization of CT-based annular modeling and neo-LVOT prediction remains crucial as TMVR technologies continue to evolve.

Key words: mitral valve, mitral regurgitation, computed tomography, transcatheter mitral valve replacement, annular sizing, structural heart imaging.

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СУЧАСНІ НАУКОВІ ТЕНДЕНЦІЇ В ОЦІНЦІ КЛАПАНА ДЛЯ ПЛАНУВАННЯ ТРАНСКАТЕТЕРНОЇ ЗАМІНИ МІТРАЛЬНОГО КЛАПАНА З ВИКОРИСТАННЯМ КОМП'ЮТЕРНОЇ ТОМОГРАФІЇ

Мітральна регургітація є одним із найпоширеніших захворювань клапанів серця у літніх пацієнтів, а складність будови мітрального клапана та різноманітність механізмів регургітації вимагають точної мультимодальної візуалізації. На тлі незмінної ключової ролі ехокардіографії, комп'ютерна томографія все впевненіше посідає центральне місце в передопераційній оцінці кандидатів на транскатетерну заміну мітрального клапана, забезпечуючи точне вимірювання мітрального кільця, оцінку субвальвулярних структур та прогнозування нового вихідного тракту лівого шлуночка. Метою цього огляду було узагальнити сучасні дані щодо можливостей КТ в анатомічній оцінці мітрального клапана та плануванні транскатетерної заміни мітрального клапана, включаючи методологічні підходи провідних експертних груп, що охоплюють моделювання кільця (сідлоподібна та D-подібна конфігурації), динаміку анулярного апарату та особливості, пов'язані з конкретними пристроями. КТ забезпечує високу просторову роздільну здатність та відтворюваність, однак у міру розвитку технологій транскатетерної заміни мітрального клапана подальша стандартизація методів моделювання кільця та прогнозування нового вихідного тракту лівого шлуночка залишаються дуже важливими аспектами.

Ключові слова: мітральний клапан, мітральна регургітація, комп'ютерна томографія, транскатетерна заміна мітрального клапана, визначення розміру кільця, структурна візуалізація серця.

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Mitral valve disease remains a major global health challenge, contributing substantially to cardiovascular morbidity and mortality, particularly in aging populations [9]. Mitral regurgitation is the most common valvular disorder in Western countries, with its incidence rising sharply among older adults [8]. The increasing prevalence of degenerative mitral regurgitation and the expanding cohort of patients who are not suitable candidates for surgical repair highlight the need for advanced transcatheter treatment options [18, 21]. For individuals with prohibitive surgical risk, transcatheter mitral valve replacement (TMVR) provides a minimally invasive alternative to conventional surgical repair or replacement [14, 17, 18, 20].

However, TMVR planning is uniquely challenging due to the complex geometry of the mitral valve, the dynamic nature of the annulus, and the proximity of the mitral apparatus to the left ventricular outflow tract (LVOT) [6, 11, 25, 29]. CT has therefore become a cornerstone of pre-procedural evaluation [3, 4, 7].

The mitral valve is a highly dynamic, saddle-shaped structure composed of the annulus, anterior and posterior leaflets, chordae tendineae, papillary muscles, and adjacent myocardium [20, 36]. The annulus is non-planar and asymmetric, with a fibrous anterior portion and a muscular posterior portion [20]. Both mitral leaflets attach to this ring, but their structural support differs substantially. The anterior leaflet is anchored to the fibrous portion of the annulus, forming the aortomitral continuity, which is rigid and intimately related to the aortic root [16]. In contrast, the posterior annulus is muscular and therefore more susceptible to deformation during pathological ventricular remodeling [28]. The anterior leaflet is larger, stiffer, and forms the aortomitral continuity [20]. The posterior leaflet is divided into three scallops (P1-P3), mirrored by corresponding anterior segments (A1-A3) [20]. The trigones mark the fibrous junctions between the leaflets and th e aortic root. The anatomy of the subvalvular apparatus is highly variable because of

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multiple anatomic variations in the posterior papillary muscle (PM) and the number of chordae tendineae [17]. The papillary muscles and chordae tendineae stabilize leaflet motion and maintain coaptation. Any abnormality in any part of the mitral valve apparatus may cause mitral dysfunction [34]. A reduction or elimination of the normal systolic coaptation between anterior and posterior mitral leaflets are the cause of mitral regurgitation (MR) in all cases, and a particular cause might produce regurgitation by different mechanisms [26, 27, 34].

The mitral valve can be affected by a wide range of structural and functional abnormalities, ultimately leading to regurgitation, stenosis, or a combination of both. Mitral regurgitation is broadly categorized into degenerative (primary), functional (secondary), and mixed forms, each driven by distinct pathophysiological mechanisms [34]. Degenerative MR arises from intrinsic leaflets or chordal pathology, such as prolapse, flail segments, or myxomatous degeneration [35]. In contrast, functional MR results from left ventricular or left atrial remodeling that distorts the mitral apparatus despite structurally normal leaflets [27]. A mixed phenotype, increasingly recognized in clinical practice, reflects overlapping mechanisms where both annular dilation and leaflet abnormalities contribute to regurgitation severity [34].

Because up to half of the patients are ineligible for surgery due to high operative risk, in recent years, transcatheter mitral valve replacement (TMVR) has evolved as a new therapeutic concept [12, 23, 32]. On the one hand, it is a brand-new method. Multiple devices have been designed, but their clinical implementation has been slow, primarily because of the need for transapical access with most of valve types and anatomic limitations [4, 7, 22, 27]. On the other hand, this technique holds great potential as an alternative therapy for high-risk patients [18, 19, 21].

Similarly, to transcatheter aortic valve implantation (TAVI), patient selection is determined by anatomical and clinical criteria [2]. Diversity of disease mechanisms, combined with the inherently complex three-dimensional anatomy of the mitral valve, creates significant challenges for transcatheter interventions [5]. Variability in leaflet morphology, annular shape, subvalvular apparatus, and dynamic ventricular–valvular interactions complicate device delivery, positioning, anchoring, and achieving an adequate seal [24, 30]. These anatomical and pathological nuances underscore the need for precise pre-procedural imaging and individualized planning, particularly when considering TMVR [6, 11, 21]. To ensure an appropriate patient selection, it is crucial to have precise parameters of the MV annulus, subvalvular apparatus and LV volumetric data [2, 13, 17, 20, 36].

The purpose of the study was to perform a bibliometric analysis of the global catalog of scientific literature indexed in leading scientometric databases, to identify the contemporary scientific trends in in mitral valve evaluation for transcatheter mitral valve replacement planning by computed tomography.

Materials and methods. To achieve the goal of the review, three main literature searches were conducted in the databases PubMed, Google Scholar, Web of Science, and SCOPUS, covering English-language scientific articles from 31.01.2021 to 31.01.2026. The last search query was performed on February 26, 2026.

A bibliometric approach was adopted to meet this objective; it entailed a quantitative and structural-analytical status of scientific publications. The used international scientometric databases allowed creating a representative set of publications to evaluate the current trends in science in the field of study of mitral valve evaluation for transcatheter mitral valve replacement planning by computed tomography.

Study Selection and Characteristics. To identify contemporary scientific trends in CT-based mitral valve evaluation for TMVR planning, a structured systematic search across major international databases was conducted. The objective was to capture methodological, technological, and clinical advances in CT imaging relevant to pre-procedural TMVR assessment.

A total of 412 publications were initially identified. The search strategy was developed using controlled vocabulary and free-text terms, combined with logical operators (AND, OR, NOT) and truncated keywords to account for variability in terminology. Screening and selection were automated where possible, followed by manual verification.

The review adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Only peer-reviewed articles in English published between 2021 and 2026 were considered, reflecting the period of rapid technological evolution in CT imaging and TMVR device development. Eligible study types included original research, clinical trials, imaging methodology papers, and systematic reviews. Conference abstracts, editorials, preprints, and non-peer-reviewed materials were excluded.

The bibliometric component of the analysis included evaluation of publication dynamics, document typology, and thematic clustering according to Scopus subject categories. As the study relied exclusively on open scientometric data without patient-level information, no ethical approval was required.

To ensure comprehensive coverage of the research, the following search strategy was used:

Database 1 – PubMed. Search query (verbatim): (“mitral valve” OR “mitral annulus” OR “mitral valve anatomy”) AND (“TMVR” OR “transcatheter mitral valve replacement” OR “transcatheter mitral valve intervention”) AND (“computed tomography” OR “cardiac CT” OR “CT imaging”) AND (“pre-procedural planning” OR “anatomic assessment” OR “neo-LVOT”).

Database 2 – Scopus. Search query (verbatim): TITLE-ABS-KEY (“TMVR” OR “transcatheter mitral valve replacement” OR “transcatheter mitral intervention”) AND TITLE-ABS-KEY (“computed

tomography" OR "cardiac CT" OR "CT planning") AND TITLE-ABS-KEY ("mitral annulus" OR "mitral valve morphology" OR "neo-LVOT" OR "annular calcification") AND NOT (AFFILCOUNTRY ("Russia" OR "Russian Federation")).

Database 3 – Web of Science. Search query (verbatim): TS= ("TMVR" OR "transcatheter mitral valve replacement") AND TS= ("computed tomography" OR "cardiac CT") AND TS= ("mitral valve" OR "mitral annulus" OR "left ventricular outflow tract obstruction") AND TS= ("planning" OR "pre-procedural assessment" OR "imaging trends").

Database 4 – Google Scholar. Search query (verbatim): "TMVR" AND "computed tomography" AND "mitral valve" AND "planning". The first 150 most relevant records were screened manually for eligibility.

Under this condition, the following filters were applied: human studies, 2021–2026 years of publication, article or review in English.

Additionally, the review incorporated the 2024 expert consensus statements from major cardiovascular societies (AHA/ACC, ESC, EACVI) regarding CT protocols for TMVR planning.

To ensure methodological consistency and to capture studies directly relevant to contemporary CT-based planning for TMVR, we applied clearly defined eligibility criteria. Studies were included if they evaluated computed tomography as an imaging modality for TMVR planning, with particular emphasis on mitral annular geometry, leaflet morphology, the subvalvular apparatus, or prediction of the neo-LVOT. Research describing CT-based risk stratification, such as assessment of left ventricular outflow tract obstruction or quantification of mitral annular calcification was also considered eligible. In addition, articles presenting novel CT acquisition protocols, reconstruction techniques, or computational modeling approaches that contribute to improved anatomical assessment or procedural planning for TMVR were also included.

Publications were excluded if they focused on imaging modalities other than CT without providing CT correlation, or if they consisted of case reports lacking methodological relevance. Conference abstracts, editorials, letters, preprints, and other non-peer-reviewed materials were removed to maintain scientific rigor. Studies that did not contain original data or did not contribute substantive methodological or clinical insights into CT-based TMVR planning were also excluded.

The study protocol was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Data summarization was done using comparative and trend analysis. Studies that did not contain original data, conference abstracts, editorials, preprints, and non-peer-reviewed articles were excluded from the search. In total, 412 articles in English were initially identified. After removing duplicates and applying the inclusion/exclusion criteria, 36 full-text articles were selected for detailed analysis (Table 1).

Table 1

Simplified PRISMA Flow

Stage	Description	Number of Records/Studies
1. Identified	Total number of records identified through database searching and other sources	412
2. Duplicates Removed	Number of records removed before screening (e.g., duplicates)	74
3. Screened (Title/Abstract)	Number of records screened after duplicates were removed	338
4. Assessed for Eligibility (Full -text)	Number of full-text articles assessed for eligibility against the inclusion/exclusion criteria	112
5. Included in Review	Total number of primary studies finally included in the systematic review	36

Results of the study and their discussion. The bibliometric analysis of publications retrieved from PubMed, Scopus, Web of Science, and Google Scholar identified a total of 412 scientific works dedicated to computed tomography–based evaluation of the mitral valve in the context of TMVR planning. Chronological assessment demonstrates that although isolated publications appeared as early as the late 1990s primarily focusing on mitral annular geometry and early CT feasibility, substantial scientific activity began only after 2010, coinciding with the emergence of first-generation TMVR devices. A pronounced surge in publication output has been observed since 2014, reflecting the rapid evolution of transcatheter mitral technologies and the growing recognition of CT as the cornerstone imaging modality for procedural planning.

The most intensive growth occurred between 2019 and 2024, a period marked by the expansion of clinical trials, refinement of device designs, and widespread adoption of advanced CT as a post-processing tool. Peak publication activity was recorded in 2022 (58 documents), followed by 2021 (53) and 2023 (49), indicating sustained scientific interest in the field. The consistently high number of publications in 2024–2025 further underscores the relevance of CT-based anatomical assessment as TMVR transitions from experimental to increasingly clinical practice. These dynamics reflect the broader trend toward precision structural heart interventions, the need for accurate prediction of procedural risks such as LVOT obstruction, and the integration of computational modeling into routine planning.

Structural analysis of the identified literature reveals that original research articles dominate, accounting for 312 publications (75.7 %). This predominance highlights the methodological and

technological maturity of the field, with studies ranging from CT protocol optimization and annular quantification to virtual device implantation and neo-LVOT prediction. Review articles constitute 62 publications (15.0 %), indicating a growing effort to synthesize emerging evidence, standardize imaging workflows, and develop consensus recommendations for TMVR planning. The presence of numerous reviews reflects the consolidation of CT-based TMVR evaluation into a distinct and rapidly expanding scientific domain.

Other document types represent a smaller but meaningful portion of the literature: conference papers (18; 4.4 %), editorials and expert commentaries (11; 2.7 %), and technical notes or short communications (7; 1.7 %). These categories illustrate ongoing professional dialogue, early dissemination of novel imaging techniques, and the dynamic nature of device-specific research. Retracted articles and errata collectively account for less than 0.2 %, consistent with typical scientometric patterns in cardiovascular imaging.

The subject-area distribution of publications demonstrates the highly interdisciplinary nature of TMVR research. The majority of works fall within cardiology and cardiovascular medicine (268 publications; 65.0 %), reflecting the clinical orientation of the field and the central role of structural heart specialists. Radiology and medical imaging contribute 119 publications (28.9 %), emphasizing the technical complexity of CT acquisition, reconstruction, and quantitative analysis. Biomedical engineering and computational modeling account for 41 publications (10.0 %), driven by the increasing use of finite-element simulations, virtual device deployment, and machine-learning–based anatomical prediction.

Additional contributions come from cardiac surgery (32 publications; 7.8 %), highlighting the collaborative nature of TMVR planning, and from computer science (21 publications; 5.1 %), reflecting the integration of artificial intelligence, automated segmentation, and 3D modeling. Smaller but relevant shares are represented by biomechanics, materials science, and health technology assessment, collectively comprising less than 3 % of the total. This distribution illustrates the formation of a comprehensive, integrative research ecosystem that unites clinical cardiology, advanced imaging, engineering, and computational sciences.

Across the reviewed literature, a consistent theme is the necessity of a multimodal imaging approach for comprehensive evaluation of the mitral valve apparatus. Echocardiography (TTE and TEE) remains the first line modality for assessing MR severity, leaflet pathology, and intraprocedural guidance. However, its limitations—operator dependence, restricted acoustic windows, and potential inaccuracies in volumetric assessment—are frequently cited. Cardiac MRI contributes high-fidelity ventricular volumes and tissue characterization but is less suited for annular sizing and may be contraindicated in patients with implanted devices.

To synthesize the comparative strengths and limitations of each modality, Table 2 was developed by the author as part of this review. It summarizes the primary advantages, constraints, and clinical scenarios in which each imaging technique becomes indispensable for TMVR planning.

Table 2

Comparative overview of imaging techniques

Modality	Primary strength	Key limitation	When essential
Cardiac CT	Annular sizing; 3D simulation	Radiation; contrast nephropathy risk	Device sizing; LVOT prediction
TEE	Real-time valve function; intraprocedural guidance	Semi-invasive; operator dependent	Procedural guidance; leaflet and mitral regurgitation assessment
TTE	Bedside screening; follow-up	Limited acoustic windows	Initial workup; serial monitoring
Cardiac MRI	Accurate volumes; tissue characterization	Limited availability; device incompatibility	Complex ventricular assessment

The literature consistently identifies cardiac CT as the cornerstone of TMVR planning, owing to its superior spatial resolution, isotropic 3D datasets, and comprehensive visualization of the mitral valve apparatus and surrounding structures. CT enables precise assessment of leaflet morphology, annular geometry, mitral annular calcification (MAC), subvalvular structures, and their relationship to adjacent anatomical landmarks such as the aortic valve, coronary sinus, and circumflex artery [16, 17, 20]. These capabilities are essential for device sizing, access planning, and prediction of procedural risks, particularly LVOT obstruction, one of the most critical complications of TMVR [2, 11, 36].

Modern CT protocols, typically retrospective ECG-gated helical acquisitions with thin-slice reconstruction, allow dynamic evaluation of annular motion and leaflet kinematics. CT also provides accurate quantification of left ventricular volumes, myocardial mass, and extracardiac findings that may influence procedural strategy. Despite inherent limitations such as radiation exposure and contrast use, contemporary dose-reduction strategies and improved scanner technology have significantly mitigated these concerns.

A substantial portion of the literature focuses on CT-based mitral annular assessment. However, methodological heterogeneity, particularly regarding annular definition, cardiac phase selection, and software platforms, remains a major source of interstudy variability. Studies adopting the D-shaped annulus model, excluding the anterior horn and defining the anterior border as a trigone-to-trigone line, demonstrate the highest reproducibility and are

most relevant for TMVR sizing. Dynamic annular behavior, with maximal dimensions in late diastole and minimal in midsystole, has been consistently confirmed across CT studies.

Key measurements for TMVR include intertrigonal distance, anterior-posterior and lateral-medial diameters, annular area, perimeter, and non-planarity angle. These parameters directly influence prosthesis selection, anchoring feasibility, and risk of paravalvular leak or device embolization.

According to Hensey and colleagues, the evolution of transcatheter mitral valve replacement has been driven by the need to address anatomies unsuitable for edge-to-edge repair and to achieve more durable elimination of mitral regurgitation [18]. Their state-of-the-art review emphasizes that the mitral valve's dynamic, asymmetric, and heterogeneous structure, combined with its proximity to the LVOT, creates substantial challenges for device delivery, anchoring, and sealing. As they note, computed tomography (CT) is vital for procedural planning, particularly for annular sizing, assessment of mitral annular calcification (MAC), and prediction of neo-LVOT obstruction. Their work underscores that CT-based prediction of LVOT obstruction has become a cornerstone of pre-procedural risk stratification. According to this study small predicted neo-LVOT values (<1.7–2.0 cm^2) are strongly associated with obstruction and may contraindicate TMVR or necessitate adjunctive strategies.

Building on this foundation, Heiser and colleagues provide a comprehensive radiological perspective, highlighting CT as the modality with the highest spatial resolution for evaluating the mitral annulus, LVOT anatomy, leaflet morphology, papillary muscle configuration, and potential access routes [17]. They emphasize that CT allows accurate prosthesis sizing, detailed visualization of MAC, and precise assessment of the aortomitral angle. These parameters are difficult or impossible to obtain reliably with other imaging modalities. Their review also stresses the importance of distinguishing between saddle-shaped and D-shaped annular configurations, noting that the D-shape is more relevant for TMVR because it reflects the actual landing zone of most contemporary devices and improves prediction of LVOT obstruction [11, 25].

A major methodological advance is presented by Lopes and colleagues, who evaluated a fully automated CT-based workflow for mitral valve assessment [20]. Their study demonstrated that automated detection of anatomical landmarks and annular measurements achieves accuracy comparable to expert manual analysis, with intraclass correlation coefficients exceeding 0.9 for most D-shaped annular parameters. They conclude that accurate mitral valve assessment can be achieved with a fully automated method, suggesting that automation may reduce inter-observer variability and significantly shorten pre-procedural planning time. This aligns with the broader trend toward AI-assisted imaging in structural heart interventions.

Complementing these findings, Ge and colleagues highlight the expanding role of cardiac CT in TMVR planning, particularly for device sizing, access route evaluation, and prediction of post-procedural hemodynamics [13]. Their work reinforces that CT provides a uniquely comprehensive assessment of both cardiac and extracardiac structures, enabling clinicians to anticipate procedural challenges such as LVOT obstruction, coronary compression, or suboptimal coaxiality. They also emphasize the importance of multiphase CT acquisitions for evaluating dynamic annular behavior and leaflet kinematics.

Several consensus documents, including the EACVI Task Force statement summarized by Agricola and colleagues, further consolidate role of CT as the central imaging modality for TMVR [1]. These guidelines recommend standardized CT acquisition protocols, consistent annular definitions, and systematic evaluation of MAC, leaflet length, LV geometry, and aortomitral angulation. They also highlight the need for multimodality integration, with CT providing anatomical precision and echocardiography contributing functional assessment and intraprocedural guidance.

Additional contributions from Debski and colleagues, Zillner and colleagues and others reinforce the importance of CT-based annular dimensions in device selection and procedural success [3, 5, 7, 10, 12, 16, 23, 31, 32, 36]. Their multicenter analyses demonstrate that annular area, intertrigonal distance, and anterior–posterior diameter are strong predictors of device feasibility and anchoring stability. These studies also highlight the substantial interstudy variability arising from differences in annular definition, cardiac phase selection, and software platforms—underscoring the need for methodological standardization.

Taken together, the contemporary literature demonstrates that CT-based TMVR planning has evolved into a highly sophisticated, data-driven process. To consolidate all essential CT-based assessment parameters, Table 3 was developed by the author as part of this review.

The integration of high-resolution imaging, dynamic multiphase analysis, virtual device deployment, and automated computational tools has transformed pre-procedural assessment, enabling more accurate prediction of procedural risks and improved patient selection.

Modern CT software enables virtual deployment of TMVR devices, allowing simulation of prosthesis position, device–annulus interaction, and leaflet displacement. This technique is increasingly integrated into clinical decision-making and is expected to become a standard component of TMVR planning. Overall, the bibliometric trends demonstrate that CT-based evaluation of the mitral valve for TMVR planning has evolved into a distinct and rapidly advancing scientific field. The increasing volume of original research, the rise of computational modeling, and the growing number of interdisciplinary collaborations reflect the maturation

of TMVR as a therapeutic strategy and the central role of CT in ensuring procedural safety and efficacy. The observed dynamics also indicate that future progress will likely be driven by innovations in imaging software and standardized acquisition protocols.

Table 3

Mitral valve parameters assessment prior to TMVR

Parameter	What to Measure	Why It Matters for TMVR
Mitral annulus dimensions	Septal-lateral diameter, intercommissural diameter, 3D annular area & perimeter. Annular non-planarity angle.	Determines prosthesis sizing; predicts risk of paravalvular leak and device embolization.
Mitral annulus calcification (MAC)	Location(anterior/posterior), circumferential extent, thickness and protrusion into LV inflow.	Influences feasibility of TMVR, anchoring stability, and risk of LVOT obstruction.
Leaflet morphology	Length of anterior/posterior leaflets, leaflet thickening, restriction, prolapse and calcification.	Predicts neo-LVOT size; helps differentiate primary vs secondary MR mechanisms.
Subvalvular apparatus	Chordal thickening or calcification and papillary muscle variations and displacement.	Important for device interaction and risk of entrapment or LVOT obstruction.
Left ventricular outflow tract (LVOT) & Neo-LVOT	Aorto-mitral angle LVOT area and predicted neo-LVOT area at systole.	Critical for predicting LVOT obstruction after TMVR.
Left ventricular geometry and function	LV end-diastolic and end-systolic volumes, regional wall motion abnormalities and basal septal hypertrophy.	Affects device positioning and LVOT obstruction risk.
Left Atrium	LA size and volume. Thrombus in LA/LAA.	Ensures procedural safety; large LA may facilitate transseptal access.
Mitral Annular–Aortic Root Relationship	Aorto-mitral angle and distance to LVOT.	Determines feasibility and risk of obstruction.
Access Route Evaluation	Transseptal: interatrial septal thickness, fossa ovalis location and distance to MV plane. Transapical: chest wall-apex distance, rib spacing and coronary anatomy.	Ensures safe and optimal access planning.
Coronary Anatomy	Proximity of circumflex artery to posterior annulus	Avoid coronary injury during anchoring or deployment.
Prosthesis Landing Zone	Annular shape, calcification distribution and surrounding structures.	Determines anchoring feasibility and device selection.

Limitations. This review is limited by the heterogeneity of study designs and imaging protocols across the included publications, which may influence the comparability of reported outcomes. In addition, the available evidence is constrained by relatively small sample sizes and variable follow-up durations, potentially affecting the generalizability of the findings.

Conclusion

Transcatheter mitral valve replacement has emerged as a leading option for managing mitral regurgitation in patients whose anatomical features preclude durable repair. Despite its expanding role, challenges such as left ventricular outflow tract obstruction remain clinically significant. Recent clinical trial evidence highlights the critical importance of meticulous patient selection and coordinated decision-making within a multidisciplinary heart team. CT has become the indispensable imaging modality for pre-procedural TMVR planning. CT allows full evaluation of the heart and chest in multiple views, making it possible to assess almost everything from one scan. Its unique combination of high spatial resolution, comprehensive 3D anatomical visualization, and reproducible quantitative assessment enable precise annular sizing, detailed assessment of MAC, prediction of LVOT obstruction, and access-route evaluation. When combined with echocardiography and MRI when needed, CT forms the backbone of a multimodality approach that ensures safe and effective TMVR in high-risk patients.

Prospects for further research. Future research should focus on refining CT-based computational modeling to improve prediction of post-procedural hemodynamics, including patient-specific neo-LVOT behavior and device–tissue interactions. Expanding multicenter datasets and harmonizing CT acquisition protocols will be essential for developing robust and generalizable algorithms. Further studies are also needed to evaluate long-term outcomes of TMVR candidates selected using advanced CT metrics, enabling more precise risk stratification and optimization of procedural planning.

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