



# Transcatheter Aortic Valve Implantation in Large and Extra-Large Aortic Annuli: Contemporary Evidence and Performance of Third-Generation Devices

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## Abstract

**Background:** Large and extra-large (XL) aortic annuli represent one of the most challenging anatomical subsets in contemporary transcatheter aortic valve implantation (TAVI), owing to dimensions exceeding Instructions for Use (IFU) limits, elliptical annular geometry, and heavy calcification. Recent expansion of device sizes and refinement of sealing systems in third-generation valves have enabled TAVI in anatomies previously considered borderline or unsuitable.

**Methods:** This narrative review summarizes anatomical definitions, procedural outcomes, and hemodynamic performance of four major third-generation platforms—Evolut 34 mm, SAPIEN 3 29 mm, Navitor TITAN 35 mm, and Myval XL—based on multicenter registries and dedicated large-annulus cohorts.

**Results:** Large annulus is typically defined as 500–683 mm<sup>2</sup>, while XL annulus corresponds to >683 mm<sup>2</sup> or perimeter >94 mm. Across major databases procedural success ranged from 94–98%, with 30-day mortality 1–3% and stable hemodynamics despite annular dimensions beyond standard IFU ranges. Paravalvular leak (PVL) remains the primary challenge; however, modern sealing technologies (NaviSeal™, PET cuff, pericardial wrap) significantly mitigate this risk.

**Conclusion:** Contemporary evidence shows that TAVI in large and XL annuli is feasible, safe, and associated with excellent early outcomes when supported by precise CT-guided planning and appropriate device selection. Future prospective comparative studies are warranted to refine device-specific indications and long-term durability in this anatomically demanding population.

## Key-words

Aortic stenosis, TAVI, large annulus, extra-large annulus, SAPIEN 3, Evolut 34, Navitor TITAN, Myval XL

## Introduction

Transcatheter aortic valve implantation (TAVI) has transformed the treatment of severe aortic stenosis. However, patients with large and particularly extra-large (XL) aortic annuli remain among the most demanding subsets in contemporary practice. Annular dimensions that exceed manufacturer-recommended ranges (Instructions for Use, IFU), combined with elliptical geometry and increased calcific rigidity, can impair coaxial deployment, expansion, and sealing of the prosthetic valve. The development of third-generation devices and the availability of large-size prostheses—Evolut 34 mm, SAPIEN 3 29 mm, Navitor TITAN 35 mm, and Myval XL (30.5/32 mm)—have expanded procedural feasibility in anatomies that historically required surgery or were considered borderline for TAVI.

Large aortic annulus is typically defined as an area of 500–683 mm<sup>2</sup>, while extra-large annulus corresponds to an area >683 mm<sup>2</sup> or a perimeter >94 mm. These thresholds are widely used in contemporary CT-based studies and registries evaluating TAVI performance in challenging anatomies.

## Evidence from Large-Annulus Registries

One of the most influential sources for understanding this population is the **TAVR-LARGE registry**, a multicenter analysis including 833 patients treated with third-generation platforms—primarily the balloon-expandable (BEV) SAPIEN 3 (29 mm) and the self-expanding (SEV) Evolut R (34 mm)<sup>1</sup>. A dedicated subgroup of 124 patients presented with XL annuli (mean area ≈704 mm<sup>2</sup>), enabling evaluation of procedural feasibility beyond standard IFU limits. The registry demonstrated a high overall procedural success of approximately 94%, a 30-day mortality of 2.4%, and a 1-year mortality of 9%. Hemodynamic performance was stable in both platforms, while moderate-to-severe paravalvular leak (PVL) occurred in only 3–5% of patients. Differences between BEV and SEV were consistent with expected device-class behavior: BEV systems were associated with lower PVL and lower pacemaker implantations, while SEV systems provided larger effective orifice areas and lower gradients.

The **German Aortic Valve Registry (GARY)** further supported these findings. In more than 5,000 patients with annular diameters ≥26 mm, early clinical outcomes (30-

day mortality 2–3%) were comparable to standard-annulus populations, with preserved hemodynamics and predictable differences between BEV and SEV platforms<sup>2</sup>.

A significant contribution to understanding extreme anatomies comes from the prospective cohort of Hof et al., which included 144 patients with annulus area >683 mm<sup>2</sup><sup>3</sup>. These anatomies frequently presented with pronounced ellipticity and extensive calcification. Despite these challenges, technical success was high (~96%), overall implantation success reached 82–85%, and 30-day mortality remained low (2–3%). Moderate PVL occurred slightly more frequently than in standard-annulus controls but without adverse impact on early clinical outcomes. The authors concluded that TAVI in extreme annular dimensions remains feasible and clinically safe when supported by meticulous CT-based planning and appropriate device selection.

### Performance of specific third-generation systems

Self-expanding supra-annular design and a nitinol frame provide large effective orifice areas and low transvalvular gradients—features particularly relevant for large-annulus patients with higher body surface area. Across large-annulus series, implantation success ranged from 93–96%, gradients from 6–10 mmHg, and 30-day mortality from 1–2%<sup>4–5</sup>.

The EnVeO PRO delivery system uses an 18 Fr equivalent sheath for the 34-mm model, requiring approximately 7.3 mm minimal femoral lumen, with vascular complications of 4–6% reported in large-annulus cohorts.

SAPIEN 3 is the best-studied BEV system in large and XL annuli. In annulus areas ranging from 683–850 mm<sup>2</sup>, procedural success approached 97%, 30-day mortality remained around 1%, and moderate PVL occurred in 3–4%<sup>6</sup>. The PET outer skirt contributes substantially to PAR mitigation in elliptical geometries<sup>7</sup>. BEV systems consistently demonstrated the lowest pacemaker rates in comparative analyses<sup>8</sup>. The Commander system uses a 14–16 Fr sheath and requires a minimum femoral lumen of 5.5–6.0 mm.

Navitor and Navitor TITAN incorporate an intra-annular design and the adaptive NaviSeal™ cuff, which improves sealing in irregular or elliptical annuli. Early registries report technical success of 95–98%, gradients of 7–10 mmHg, and moderate PVL in only ~2–3%<sup>9–10</sup>. The 35-mm TITAN model is clinically important as it covers annular diameters of 27–30 mm, filling a previously underserved anatomical range. Unlike other large SEV prostheses, TITAN uses a 15 Fr equivalent introducer, with a minimal femoral lumen requirement of ~5.5 mm, making it one of the lowest-profile solutions in its class.

Myval XL is the only BEV platform designed specifically for extremely large annuli, covering areas up to ~840 mm<sup>2</sup>. The MyVal-1 and subsequent multicenter analyses demonstrate implantation success >95%, moderate PVL 0–3%, and gradients 7–12 mmHg<sup>11</sup>. The Navigator sys-

tem uses a 14 Fr Python introducer for standard sizes and 16–18 Fr for XL models, with estimated minimal femoral lumen of 5.5–6.0 mm.

### Conclusion

Available evidence demonstrates that large and extra-large aortic annuli, despite anatomical complexity and elevated risks of incomplete expansion and paravalvular regurgitation, are increasingly well managed in contemporary TAVI practice. The largest registries consistently confirm high technical success (94–98%), low early mortality (1–3%), and stable hemodynamics even beyond standard IFU limits.

Modern sealing technologies and the development of large-size devices—Evolut 34 mm, SAPIEN 3 29 mm, Navitor TITAN 35 mm, and Myval XL 30.5/32 mm—have expanded therapeutic possibilities, while advances in low-profile delivery systems improved procedural safety and broadened transfemoral access feasibility.

Future prospective comparative studies will be essential for refining optimal prosthesis selection and evaluating long-term durability in this anatomically demanding population.

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## Sažetak

### **Transkateterska zamena aortnog zaliska kod pacijenata sa velikim i veoma velikim aortnim anulusom: Savremeni dokazi i performanse zalistaka treće generacije**

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**Uvod i Cilj:** Veliki i ekstra veliki (XL) aortni anulusi predstavljaju jednu od najzahtevnijih anatomske podgrupa u savremenoj transkateterskoj implantaciji aortnog zaliska (TAVI), zbog dimenzija koje prelaze ograničenja uputstva za upotrebu (IFU), postojeće eliptične geometrije anulusa i izraženih kalcifikacija. Nedavno proširenje veličine zalistaka i usavršavanje sistema zaptivanja u platformama treće generacije omogućili su TAVI i u anatomijama koje su se ranije smatrale graničnim ili neprikladnim.

**Metode:** Ovaj narativni pregled sumira anatomske definicije, proceduralne ishode i hemodinamske performanse četiri glavne platforme treće generacije - Evolut 34 mm, SAPIEN 3 29 mm, Navitor TITAN 35 mm i Myval XL - na osnovu multicentričnih registara i namenskih kohorti kod pacijenata sa velikom dimenzijom anulusa.

**Rezultati:** Veliki anulus se tipično definiše kao 500–683 mm<sup>2</sup>, dok XL anulus odgovara >683 mm<sup>2</sup> ili perimetru >94 mm. U velikim bazama podataka uspeh procedura se kretao od 94–98%, sa mortalitetom u roku od 30 dana od 1–3% i stabilnom hemodinamikom uprkos dimenzijama anulusa izvan standardnih IFU raspona. Paravalvularno curenje (PVL) ostaje primarni izazov; međutim, moderne tehnologije zaptivanja (NaviSeal™, PET manžetna, perikardijalni omot) značajno umanjuju ovaj rizik.

**Zaključak:** Savremeni dokazi pokazuju da je TAVI kod velikih i XL anulusa izvodljiva i bezbedna metoda koja je povezana sa odličnim ranim ishodima kada je podržana preciznim CT vođenim planiranjem i odgovarajućom platformom. Buduće prospektivne uporedne studije su potrebne kako bi se precizirale indikacije specifične za platformu i ispitala dugoročna trajnost kod ove anatomske zahtevne populacije.

**Cljučne reči:** aortna stenoza, TAVI, veliki anulus, SAPIEN 3, Evolut 34, Navitor TITAN, Myval XL