Title: Outcomes of Transcatheter vs. Surgical Aortic Valve Replacement in Bicuspid Aortic Valve Stenosis: A Systematic Review and Meta-Analysis

Abstract

Purpose

This meta-analysis compared peri-procedural and short-term outcomes of transcatheter aortic valve replacement (TAVR) versus surgical aortic valve replacement (SAVR) in severe bicuspid aortic valve (BAV) stenosis, addressing TAVR's debated efficacy in this context.

Methods

A systematic search of PubMed, ScienceDirect, and Embase up to January 2025. Pooled odds ratios (ORs) with 95% confidence intervals (CIs) were calculated using a random-effects model. Heterogeneity was assessed with the I^2 statistic, with $p<0.05$ as significant.

Results

9 observational studies with 148,401 patients (TAVR: 16,397; SAVR: 132,004) were included. TAVR showed lower odds of acute kidney injury (OR = 0.58, 95% CI: 0.35–0.97; p = 0.04), major bleeding (OR = 0.29, 95% CI: 0.12–0.69; p = 0.005), and pulmonary complications (OR = 0.44, 95% CI: 0.34–0.57; p < 0.00001) versus SAVR. However, TAVR increased risks of paravalvular leak (OR = 2.15, 95% CI: 1.20–3.88; p = 0.01) and permanent pacemaker implantation (OR = 2.08, 95% CI: 1.39–3.10; p = 0.0004). No significant differences were noted in in-hospital mortality (OR = 1.01, 95% CI: 0.53–1.92; p = 0.98), stroke (OR = 1.03, 95% CI: 0.84–1.26; p = 0.77), or vascular complications (OR = 0.67, 95% CI: 0.18–2.52; p = 0.55).

Conclusion

TAVR reduces risks of acute kidney injury, major bleeding, and pulmonary complications in BAV stenosis but raises paravalvular leak and pacemaker implantation risks compared to SAVR. Mortality and stroke rates are similar. TAVR may suit selected patients, but long-term data is needed

Keywords: Transcatheter aortic valve replacement, Surgical aortic valve replacement, Bicuspid aortic valve stenosis.

27 **Introduction**

28 1-2% of people have bicuspid aortic valve (BAV) disease, a common congenital heart condition in which the aortic
29 valve has two leaflets rather than the typical three [1]. Individuals with this congenital anomaly are at higher risk of
30 developing aortic stenosis (AS), which restricts left ventricular outflow [2]. Increased mechanical stress from the
31 aberrant valve architecture in BAV causes calcification and fibrosis, which hastens the development of AS [3].
32 Severe AS may lead to syncope, dyspnea, and chest pain, increasing the risk of heart failure if left untreated. [4].
33 Given that severe stenosis can result in substantial morbidity and mortality, it is imperative to comprehend the
34 pathophysiology and natural history of AS associated with BAV to diagnose and treat the condition promptly [5].
35 Given the unique anatomical challenges associated with BAV, selecting the optimal treatment approach remains a
36 subject of debate.

37 Traditionally, surgical aortic valve replacement (SAVR) has been the gold standard for treating AS. However, with
38 advances in transcatheter technologies, there has been a shift in the treatment landscape, raising the question of
39 whether transcatheter aortic valve replacement (TAVR) could be a viable alternative for BAV patients. Initially,
40 TAVR was reserved for high-risk patients who were not candidates for SAVR, but subsequent studies have shown
41 that TAVR is non-inferior to SAVR in patients with intermediate surgical risk [6,7]. BAV, characterized by its
42 distinctive valve structure, poses difficulties for TAVR. These challenges include the presence of a calcified raphe,
43 asymmetric calcification, and an enlarged annulus, all of which can hinder proper valve implantation. These
44 anatomical peculiarities increase the risks of complications such as paravalvular regurgitation, annular rupture, and
45 other procedural difficulties, which are of greater concern in BAV patients compared to those with tricuspid valves
46 [8]. The presence of aortopathy, a common co-occurrence in BAV patients, further complicates treatment decisions,
47 especially when considering the possibility of aortic dissection or rupture during the procedure [9]. Despite these
48 challenges, advancements in TAVR technology, including the development of new-generation valves, have reduced
49 some of the complications associated with the procedure, such as pacemaker implantation and paravalvular leak.
50 Nevertheless, some issues, such as annular rupture and stroke, persist, and the long-term durability of TAVR in
51 BAV patients remain uncertain [10]. This uncertainty stems from the limited data available on the outcomes of
52 TAVR in this specific patient population. Although there is a growing body of research exploring TAVR's use in
53 lower-risk patients, no direct randomized trials have compared TAVR and SAVR outcomes in BAV patients.
54 Studies that focus on specific BAV morphologies, like Sievers type 0, and their impact on procedural success and

55 outcomes are crucial for better understanding the viability of TAVR in this patient group [10,11]. Further
56 complicating the landscape is the increasing prevalence of BAV among younger individuals, especially as studies
57 show that a significant proportion of excised stenotic aortic valves from individuals aged 61-70 are bicuspid [12].
58 This demographic shift highlights the need for treatment strategies tailored to younger patients, who may have a
59 longer life expectancy and thus require long-term treatment considerations.

60 At present, clinical guidelines do not endorse the routine use of TAVR in BAV patients, restricting its application to
61 cases where SAVR is contraindicated. Despite some evidence suggesting comparable outcomes between TAVR in
62 BAV patients and those with tricuspid aortic valves, a direct comprehensive comparison between TAVR and SAVR
63 in BAV patients with AS is necessary. The growing off-label use of TAVR in this population underscores the need
64 for more rigorous data. This meta-analysis seeks to bridge this gap by offering a comprehensive comparison of early
65 and mid-term outcomes between TAVR and SAVR in BAV patients. By examining procedural success rates,
66 complication profiles, and the long-term durability of the procedures, this analysis aims to provide crucial insights
67 that could guide treatment decisions in this challenging cohort of patients.

68 2. METHODS

69 This systemic review and meta-analysis were conducted in accordance with the Preferred Reporting Items for
70 Systemic analysis and Meta-analysis (PRISMA) guidelines [13,14], aiming to assess the peri-procedural and short-
71 term clinical outcomes of TAVR and SAVR among patients with bicuspid aortic stenosis. The protocol for this
72 study is registered on PROSPERO (CRD42025649916).

73 2.1 Search Strategy

74 A comprehensive electronic search of PubMed, Embase and ScienceDirect was performed from their inception to
75 January 2025. The search strategy incorporated a combination of Medical Subject Headings (MeSH) terms and free-
76 text keywords. The search terms included: 'Bicuspid Aortic Valve' AND 'Aortic Stenosis,' 'Transcatheter Aortic
77 Valve Replacement' OR 'Surgical Aortic Valve Replacement'. These terms were applied to the above-mentioned
78 databases with appropriate search strings to identify relevant studies based on predefined population, intervention,
79 comparison and outcome criteria.

80 To ensure comprehensive data collection for additional references, manual search was conducted across
81 bibliographies, and grey literature including conferences proceedings, abstracts and pre-prints.

82 **2.2 Eligibility Criteria**

83 We included observational cohort studies involving patients with bicuspid aortic valve stenosis who underwent
84 either TAVR or SAVR, ensuring comparability between the two groups. Studies had to report at least one of the
85 following outcomes: primary (in-hospital mortality, stroke.) or secondary (acute kidney injury, major bleeding,
86 pulmonary complications, vascular complications).
87 We excluded studies that focused exclusively on tricuspid aortic valve stenosis or mixed valve pathologies without
88 comparable data between TAVR and SAVR. Additionally, case reports, editorials, expert opinions were excluded,
89 including duplicates.

90 **2.3 Study selection**

91 Studies were selected through a screening process based on the inclusion and exclusion criteria. Two independent
92 reviewers (**[AD, AG]**) performed the initial screening of titles and abstracts to exclude irrelevant studies. Full-text
93 articles were retrieved for all potentially eligible studies and systematically assessed for inclusion. Disagreements
94 between reviewers were resolved by discussion, and if necessary, a third reviewer (**[LR]**) was consulted.

95 **2.4 Data extraction**

96 For each included study, the following data were extracted using a standardized data collection form. These included
97 study characteristics, such as first author, publication year, country, study design, total sample size. Patient
98 demographics, such as the mean age, gender distribution, baseline comorbidities, were also included. The outcomes
99 measured were the rates of mortality, stroke, acute kidney injury, major bleeding, pulmonary complications,
100 pacemaker implantation, paravalvular leak, and vascular complications. To ensure accuracy, the extracted data were
101 cross verified by two other independent reviewers. This helps to prevent any potential discrepancies between the raw
102 and extracted data.

103 **2.5 Quality Assessment**

104 The Newcastle-Ottawa Scale (NOS) was used by two independent reviewers (DA, MP) to assess the methodological
105 quality of the included studies. The scale evaluates three domains: selection (4 items), comparability (1 item, up to 2
106 stars), and outcome assessment (3 items), with a maximum possible score of 9 stars. Discrepancies were resolved
107 through discussion with a third reviewer (MMK). [15].

108 **2.6 Statistical Analysis**

109 All statistical analyses were conducted using Review Manager 5.3 (Cochrane Collaboration) [16]. Since all included
110 outcomes were dichotomous variables, effect estimates were calculated using odds ratios (ORs) with 95%
111 confidence intervals (CIs). A random-effects model was applied throughout the analysis to account for potential
112 heterogeneity among studies. For According to the Cochrane Handbook (chapter 9), heterogeneity was considered
113 significant if the alpha value of the chi-square test is below 0.1, whereas the interpretation of the I-square test is as
114 follows: 0% to 40% not significant, 30% to 60% moderate heterogeneity, 50% to 90% substantial heterogeneity, and
115 75% to 100% considerable heterogeneity [17,18]. For each outcome, a forest plot was constructed to visually
116 analyze the data and funnel plots were generated to check the publication bias. Sensitivity analyses, including leave-
117 one-out approaches, were conducted to explore the impact of individual studies on heterogeneity and model choice.
118 Following the statistical analysis, the quality of evidence for each outcome was evaluated using the Grading of
119 Recommendations Assessment, Development, and Evaluation (GRADE) approach, assessing domains such as risk
120 of bias, inconsistency, imprecision, indirectness, and effect size to determine the certainty of evidence.

121 **3. RESULTS**

122 **3.1 Study selection**

123 The PRISMA statement flowchart **(Fig.1)** outlines the literature screening process and study selection. The initial
124 search yielded 1692 articles, from which 36 full-text articles were retrieved for assessment. Ultimately, 9 [27,34-41]
125 studies met the eligibility criteria and were included in both the qualitative and quantitative meta-analyses.

126 **3.2 Study characteristics:**

127 The included studies were nine retrospective cohort studies published between 2019 and 2024, with follow-up
128 periods ranging from hospitalization to 2.86 years. The mean age of patients undergoing TAVR ranged from 58.67
129 to 75.8 years, while for SAVR, it ranged from 51.5 to 75.7 years. The proportion of female patients varied across

studies (30.8% to 46% in TAVR vs. 27.9% to 45.3% in SAVR). Hypertension prevalence was generally higher in TAVR (60.4%–78.8%) compared to SAVR (33%–75.6%), while diabetes was reported in 15.6%–33.3% of TAVR patients and 6%–30.8% of SAVR patients. COPD rates varied across studies, with TAVR patients showing 12.2%–31.3% prevalence and SAVR patients 10%–29.1%. **(Table 1)**

3.3 Clinical outcomes

- **In-hospital mortality**: No significant difference was observed between the two surgical approaches. The pooled OR was 1.01 (95% CI 0.53-1.92; $p = 0.98$). The I^2 value was 84%, indicating considerable heterogeneity. **(Fig.2)** After excluding Sanaiha 2023, heterogeneity dropped to $I^2 = 64\%$.
- **Acute Kidney Injury**: TAVR was associated with significantly lower AKI compared to SAVR. The pooled OR was 0.58 (95% CI 0.35-0.97; $p = 0.04$). The I^2 value was 94%, indicating considerable heterogeneity. **(Fig.2)** After excluding Sanaiha 2023 and Elbadawi 2019, heterogeneity dropped to $I^2 = 48\%$.
- **Pulmonary complications**: TAVR was associated with significantly lower pulmonary complications compared to SAVR. The pooled OR was 0.44 (95% CI 0.34-0.57; $p < 0.00001$). The I^2 value was 0%, indicating no heterogeneity. **(Fig.2)**
- **Vascular complications**: No significant difference was observed between TAVR and SAVR. The pooled OR was 0.67 (95% CI 0.18-2.52; $p= 0.55$). The I^2 value was 85%, indicating considerable heterogeneity. **(Fig.2)** After excluding Mehaffey 2024, heterogeneity dropped to $I^2 = 62\%$.
- **Major bleeding**: TAVR was associated with significantly lower risk of major bleeding compared to SAVR. The pooled OR was 0.29 (95% CI 0.12-0.69; $p = 0.00001$). The I^2 value was 99%, indicating considerable heterogeneity. **(Fig.3)** After excluding Sanaiha 2023 and Mehaffey 2024, heterogeneity dropped to $I^2 = 67\%$.
- **Stroke**: No significant difference was observed between the two surgical approaches. The pooled OR was 1.03 (95% CI 0.84-1.26; $p = 0.77$). The I^2 value was 1%, indicating no heterogeneity. **(Fig.3)**
- **Permanent Pacemaker Implantation**: TAVR was associated with a higher rate of permanent pacemaker implantation compared to SAVR. The pooled OR was 2.08 (95% CI 1.39-3.10; $p <= 0.0004$). The I^2 value

157 was 91%, indicating considerable heterogeneity. **(Fig.3)** After excluding Mehaffey 2024, heterogeneity
158 dropped to $I^2 = 65\%$.

159 - **Paravalvular leak**: TAVR was associated with a significantly increased risk of paravalvular leak
160 compared to SAVR. The pooled OR was 2.15 (95% CI 1.20-3.88; $p = 0.01$). The I^2 value was 16%,
161 indicating it may represent moderate heterogeneity. **(Fig.3)**

162 **3.4 Quality Assessment**

163 Most studies scored between 8 and 9 stars, indicating high methodological quality. Specifically, Husso 2021 and
164 Mehaffey 2024 achieved the highest score of 9 stars, while the other studies (Elbadawi 2019, Gibson 2022,
165 Majmunder 2022, Mentias 2020, Sanaiha 2023, Tsai 2021) received 8 stars. Soud 2021 received the lowest score of
166 6 stars. The discrepancies in ratings were resolved through discussion with a third reviewer. **(Supplementary Table
167 1)**

168 **3.5 Publication Bias**

169 Publication bias was assessed using funnel plots for the outcomes of transcatheter vs. surgical aortic valve
170 replacement in bicuspid aortic valve stenosis. No evidence of publication bias was observed for in-hospital
171 mortality, acute kidney injury, vascular complications, major bleeding, and permanent pacemaker implantation, with
172 symmetrical distributions. Stroke, pulmonary complications, and paravalvular leak showed evidence of publication
173 bias, indicated by asymmetrical plots with gaps in the lower left quadrant, suggesting potential underrepresentation
174 of smaller studies with non-significant or negative results. **(Supplementary Fig.1,2)**

175 **3.6 GRADE Assessment**

176 The certainty of evidence across the assessed outcomes varied, predominantly reflecting moderate risk of bias due to
177 observational study designs with 8-9 stars. Several outcomes exhibited serious inconsistency, indicated by high
178 heterogeneity (I^2 values ranging from 85% to 99%), and moderate imprecision due to wide confidence intervals.
179 Despite no serious concerns of indirectness, the overall certainty ranged from very low to moderate. Outcomes such
180 as pulmonary complications and paravalvular leak demonstrated moderate certainty, while others like in-hospital
181 mortality, vascular complications, major bleeding, and permanent pacemaker implantation were rated very low due

to heterogeneity and imprecision. This variation underscores the need for cautious interpretation of effect sizes and highlights areas requiring more robust evidence. **(Supplementary Table 2)**

4. DISCUSSION

The optimal treatment strategy for BAV stenosis remains a topic of debate, with both TAVR and SAVR having their proponents. Unlike tricuspid aortic valves, BAV present unique challenges, including irregular annular shapes, increased calcification, and a higher risk of complications such as paravalvular leak and pacemaker implantation. Given these challenges, understanding the comparative effectiveness of TAVR and SAVR in managing BAV stenosis is crucial for refining clinical practice. This meta-analysis synthesizes data from multiple studies to assess in-hospital mortality, procedural risks, and complications, providing a clearer understanding of the outcomes associated with each approach

The primary outcome of this analysis was in-hospital mortality, which serves as a key measure of procedural safety and immediate postoperative risk. Our findings indicate no significant difference in in-hospital mortality between TAVR and SAVR, suggesting that TAVR does not confer an increased early mortality risk in appropriately selected BAV patients. However, significant heterogeneity ($I^2 = 84\%$) underscores the complexity of patient selection and procedural execution, highlighting the need for individualized treatment decisions. Future studies should refine patient selection criteria and investigate long-term outcomes to guide the optimal management of BAV stenosis.

In our meta-analysis, TAVR was associated with a significantly lower risk of AKI compared to SAVR indicating that TAVR patients had a 42% lower risk of AKI compared to SAVR patients. This finding aligns with the meta-analysis by Kang et al. (2024), which reported a lower incidence of AKI in TAVR patients [19]. Additionally, TAVR’s avoidance of cardiopulmonary bypass plays a significant role in reducing AKI risk, as cardiopulmonary bypass is known to contribute to renal injury due to non-pulsatile blood flow and systemic inflammatory responses [20]. Studies by Bagur et al. (2012) and Van Mieghem et al. (2014) further support our results by highlighting TAVR's reduced risk of contrast-induced nephropathy and better hemodynamic stability, especially in high-risk populations [21, 22]. The high heterogeneity observed in our analysis ($I^2 = 94\%$) suggests variability in patient populations, procedural techniques, and AKI definitions across studies, reinforcing the need for caution when interpreting these results.

208

209 Based on the results of individual retrospective studies, there seemed to be a lower risk of major bleeding in TAVR
210 compared to SAVR. Similar results were also observed in previous studies, where a lower risk of major bleeding
211 was present in TAVR compared to SAVR [19]. Consistent results observed across studies could be attributed to
212 TAVR being a less invasive procedure compared to SAVR [23]. TAVR, performed via a catheter-based approach,
213 avoids the large surgical incisions and open-heart surgery required for SAVR, thus reducing trauma to the body and
214 the potential for major blood loss. [24, 25]

215 TAVR also demonstrated a significantly lower risk of pulmonary complications compared to SAVR, consistent with
216 previous findings. The reduced need for sternotomy and cardiopulmonary bypass in TAVR patients is associated
217 with fewer pulmonary complications, including a reduced mechanical ventilation time and faster recovery [26,27]. A
218 prior meta-analysis also found that TAVR had fewer postoperative respiratory complications compared to SAVR,
219 with pooled estimates favoring TAVR [19].

220 Our analysis demonstrated that TAVR is associated with a significantly increased risk of paravalvular leak when
221 compared to SAVR. This finding is consistent with prior studies, where PVL was more commonly observed
222 following TAVR, particularly in patients with complex valve anatomies such as BAV stenosis. The higher incidence
223 of PVL following TAVR can be attributed to technical challenges, such as valve seating, annular size mismatch, and
224 calcification in the aortic annulus [28,29]. While mild PVL may be clinically insignificant, more severe forms can
225 have long-term implications for patient outcomes, potentially contributing to heart failure or requiring additional
226 interventions [30].

227 In contrast, our analysis did not reveal a significant difference in stroke rates between TAVR and SAVR. This result
228 aligns with other studies that have shown no substantial disparity in stroke risk between the two procedures. While
229 stroke remains a major concern in both interventions, the lack of a significant difference in stroke rates in our meta-
230 analysis is reassuring. However, it is important to recognize that the mechanisms leading to stroke may differ
231 between the two procedures. TAVR is associated with an increased risk of peri-procedural embolization due to the
232 placement of the valve, while SAVR may carry a stroke risk related to embolic events from surgical manipulation of
233 the aorta or valve [31]. Despite these differences in etiology, the overall incidence of stroke did not vary

234 significantly between the two interventions in our pooled analysis, suggesting that stroke risk, while concerned, may
235 not be inherently higher with TAVR.

236 Our analysis also found no significant difference in vascular complications between TAVR and SAVR, consistent
237 with previous studies. TAVR is associated with potential vascular access injuries due to the use of large-bore
238 sheaths, while SAVR's vascular complications are influenced by factors like advanced age, pre-existing vascular
239 disease, and cardiopulmonary bypass [32,33].
240 Overall, the findings from this meta-analysis contribute to understanding the comparative risks and benefits of
241 TAVR and SAVR in managing BAV stenosis. The results suggest that while TAVR may offer advantages in terms
242 of renal, pulmonary, and bleeding outcomes, it also carries an increased risk of paravalvular leak. Future studies
243 with larger sample sizes and longer follow-up periods are needed to further clarify the long-term outcomes of these
244 interventions in BAV stenosis.

245 **Clinical Implications**

246 This meta-analysis demonstrates that both TAVR and SAVR offer comparable in-hospital mortality rates for BAV
247 stenosis, suggesting that TAVR is a viable alternative to SAVR in appropriately selected patients. TAVR is
248 associated with lower risks of acute kidney injury, major bleeding, and pulmonary complications, making it
249 particularly beneficial for high-risk patients with comorbidities. However, the increased risk of paravalvular leaks
250 with TAVR highlights the importance of careful patient selection and procedural planning. These findings support
251 the use of TAVR, especially in older or frailer patients, while emphasizing the need for individualized treatment
252 strategies.

253 **Limitations**

254 This meta-analysis is limited by the retrospective design of the included studies, which may introduce bias and limit
255 causal inference. Significant heterogeneity across studies (I^2 values up to 94%) suggests variability in patient
256 populations and procedural methods, which impacts the generalizability of the results. Additionally, the analysis
257 focuses on in-hospital outcomes, lacking long-term follow-up data to assess the durability of TAVR versus SAVR.

The absence of standardized reporting on patient characteristics and the potential for publication bias further limit the robustness of the findings.

Conclusion

This meta-analysis provides strong evidence that TAVR is a safe and effective alternative to SAVR for treating BAV stenosis, particularly in high-risk patients. While both procedures show similar in-hospital mortality rates, TAVR is associated with lower risks of acute kidney injury, major bleeding, and pulmonary complications. However, the increased risk of paravalvular leak with TAVR necessitates careful patient selection. Despite some limitations, including the retrospective design and lack of long-term data, the findings support the growing use of TAVR in clinical practice for BAV stenosis, with the need for further studies to confirm these results over time.

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386 **LEGEND**

387 **Fig.1:** PRISMA flowchart outlining the literature screening process, study selection, and exclusion criteria.

388 **Fig.2:** Forest plot comparing a) in-hospital mortality; b) acute kidney injury; c) pulmonary complications;

389 d) vascular complications between TAVR and SAVR in patients with BAV stenosis.

390 **Fig.3:** Forest plot comparing a) major bleeding; b) stroke; c) permanent pacemaker implantation; d)

391 paravalvular leak between TAVR and SAVR in patients with BAV stenosis.

392 **Table 1:** Detailed characteristics of included studies and baseline characteristics.

393

394 **Figure 1:** PRISMA flowchart outlining the literature screening process, study selection, and exclusion
395 criteria.
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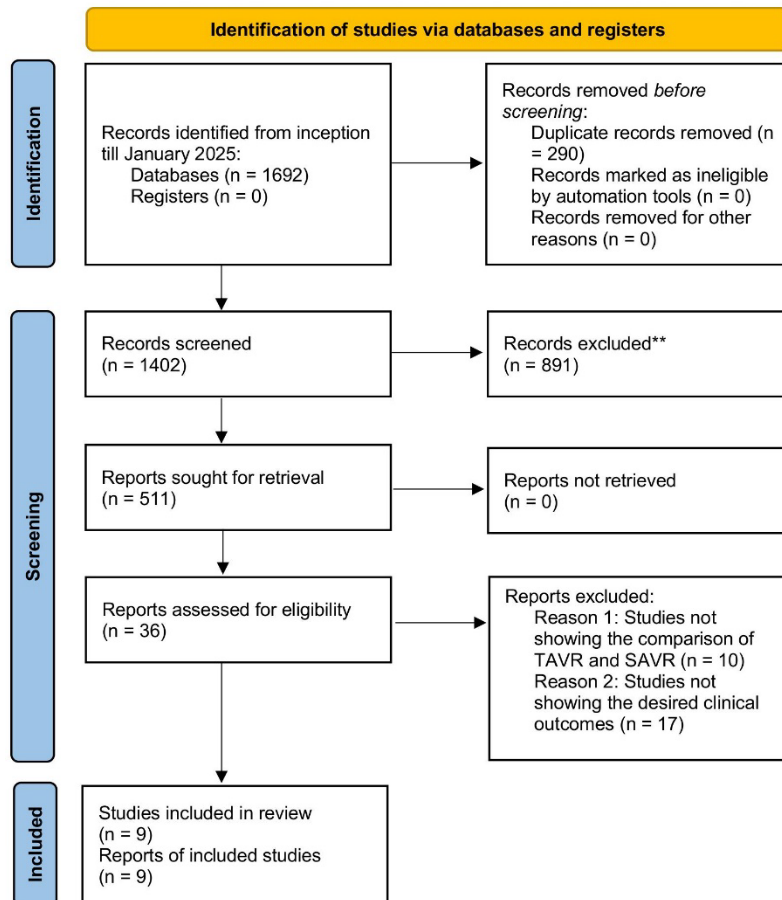

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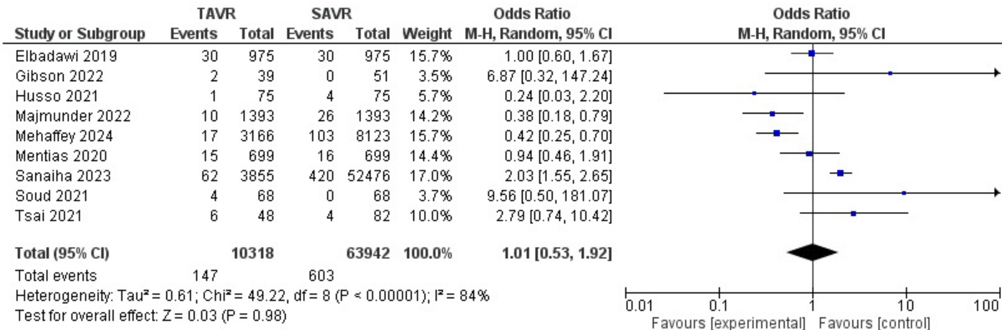
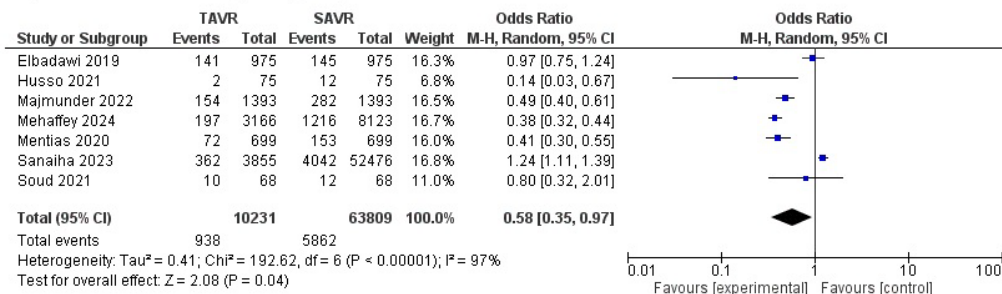
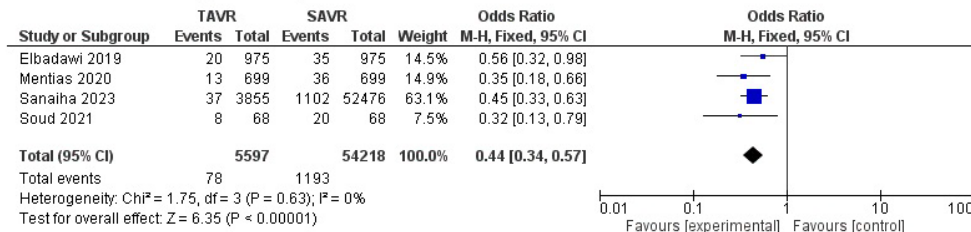
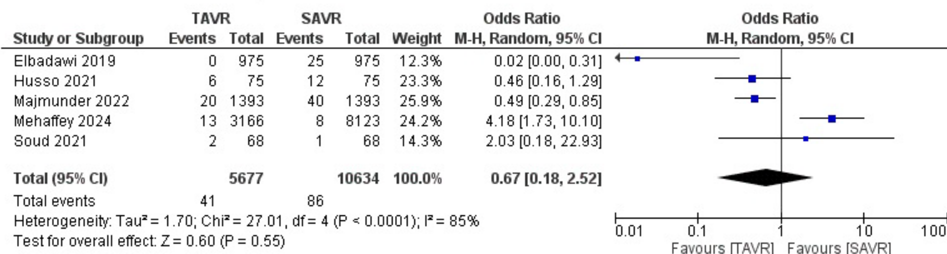
Fig.2: Forest plot comparing a) in-hospital mortality; b) acute kidney injury; c) pulmonary complications; d) vascular complications between TAVR and SAVR in patients with BAV stenosis.









Legend: Transcatheter Aortic Valve Replacement (TAVR), Surgical Aortic Valve Replacement (SAVR), Mantel-Haenszel (M-H), Confidence Interval (CI), Chi-squared test (Chi²), Degrees of Freedom (df), P-value, Heterogeneity statistic (I²), Test statistic for heterogeneity (Z), Test for overall effect (Z).

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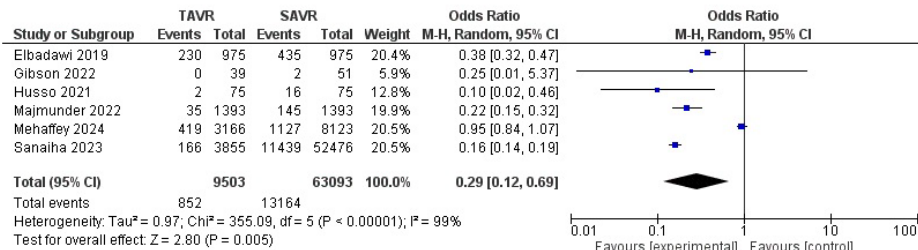
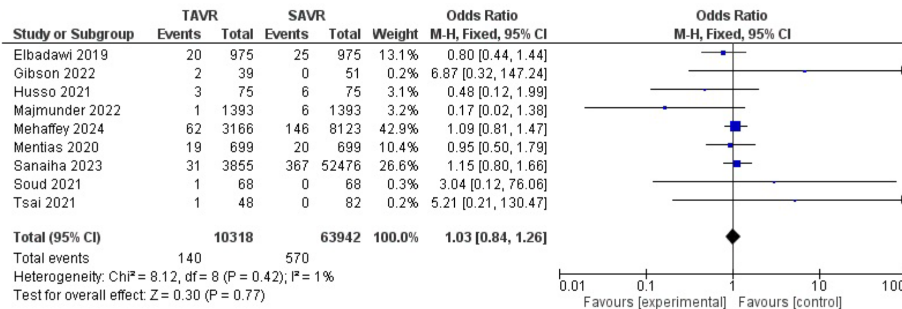
Fig.3: Forest plot comparing a) major bleeding; b) stroke; c) permanent pacemaker implantation; d) paravalvular leak between TAVR and SAVR in patients with BAV stenosis.

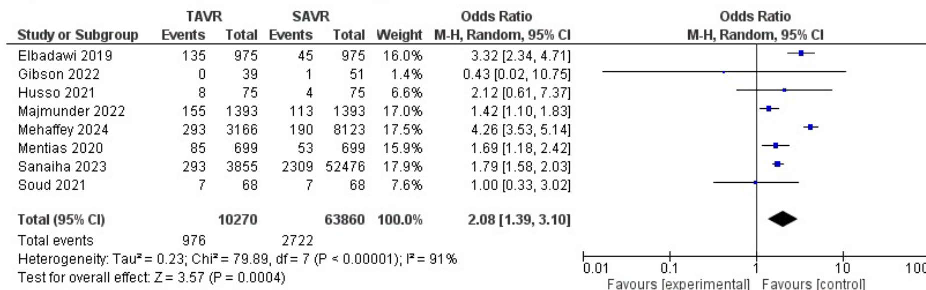
a) Major bleeding



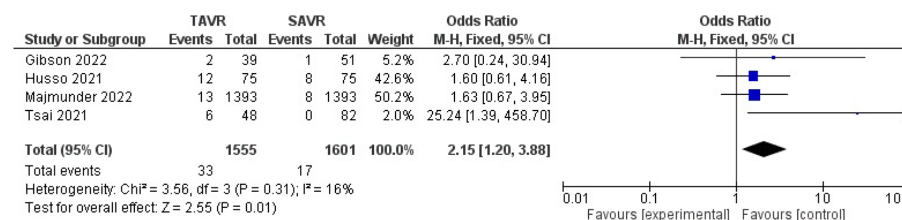
b) Stroke



c) Permanent pacemaker implantation



d) Paravalvular leak



Transcatheter Aortic Valve Replacement (TAVR), Surgical Aortic Valve Replacement (SAVR), Bicuspid Aortic Valve (BAV), Mantel-Haenszel (M-H), Confidence Interval (CI), Chi-squared test (Chi²), Degrees of Freedom (df), P-value (P), Heterogeneity statistic (I²), Test statistic for heterogeneity (Z), Test for overall effect (Z).

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418 **Table 1:** Detailed characteristics of each included study

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Author	Year	Sample Size		Study design	Age (Mean + SD)		Female (%)		Hypertension (%)		Diabetes (%)		COPD (%)	
		TAVR	SAVR		**TAVR**	**SAVR**	**TAVR**		**TAVR**	**SAVR**	**TAVR**	**SAVR**	**TAVR**	**SAVR**
Elbadawi et al. (34)	2019	975	975	Retrospective Cohort	65.70 ± 16.53	65.20 ± 11.52	40		64.6	64.6	29.7	30.8	NA	NA
Gibson et al. (35)	2022	39	51	Retrospective Cohort	71±13	53 ± 15	46		49	33	31	6	18	1[illegible]
Husso et al. (36)	2021	75	75	Retrospective Cohort	75.8 ± 8.4	75.7 ± 6.3	44		NA	NA	21.3	14.7	21.3	25.3
Majmunder et al. (37)	2022	1393	1393	Retrospective Cohort	68.3 ± 10.1	68.1± 8.6	37.8		78.8	75.6	28	29.4	31.3	28.7
Mehaffey et al. (38)	2024	3166	8123	Retrospective Cohort	71 ± 5.93	69 ± 4.45	42.2		NA	NA	26.9	19.8	NA	NA
Mentias et al. (27)	2020	699	699	Retrospective Cohort	74.7 ± 9.4	69.9 ± 6.8	NA		NA	NA	NA	NA	NA	NA
Sanaiha et al. (39)	2023	3855	524	Retrospective Cohort	58.67 ± 11.12	69 ± 10.38	30.8		NA	NA	15.6	26	17.3	29

			76									.7		.1
Soud et al. (40)	2021	68	68	Retrospective Cohort	65.0 ± 14.8	64.6 ± 12.4	32.4		72.1	36.8	23.5	23.5	25	23.5
Tsai et al. (41)	2021	48	82	Retrospective Cohort	65.7 ± 7.8	51.5 ± 32.3	41.7		60.4	48.8	33.3	12.2	NA	NA

Legend: Transcatheter Aortic Valve Replacement (TAVR), Surgical Aortic Valve Replacement (SAVR), Standard Deviation (SD), Chronic Obstructive Pulmonary Disease (COPD), and Not Available (NA).