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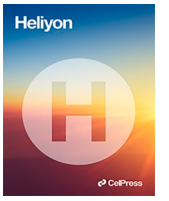

Review article

Transcatheter aortic valve implantation for patients with heyde syndrome: A literature review of case reports

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ABSTRACT

Objective: A systematic review of international case reports of patients with Heyde syndrome (HS) treated by transcatheter aortic valve implantation (TAVI) was conducted to explore the clinical characteristics of this group of patients and sirgical success. Methods: Electronic databases, including PubMed, Embase and CNKI, were searched with combinations of the search terms, Heyde syndrome, gastrointestinal bleeding, aortic stenosis, angiodysplasia and transcatheter aortic valve replacement. All case reports were screened according to inclusion criteria, and HS patient data was summarized.

Results: A total of 31 case reports concerned patients with a history of aortic stenosis and repeated gastrointestinal bleeding. Ultrasonic cardiograms (UCG) were recorded for 27 cases, including those with critical aortic stenosis (n = 26). Gastrointestinal sequelae were reported in 22 cases with duodenal and jejunal being the most common (n = 9). High-molecular-weight multimers of von Willebrand Factor (vWF-HMWM) were measured in 17 cases with the majority being lower (n = 15) and the minority normal (n = 2). All patients experienced recurrent bleeding after medication and endoscopic therapy and symptoms improved after TAVI (31/31). vWF was at normal levels in 11/12 cases post-TAVI. Twenty-five patients were followed up and 22 had no recurrence of symptoms giving an efficacy rate of 88% for TAVI in HS patients.

Conclusions: HS is characterized by angiodysplasia, aortic stenosis and von Willebrand disease with frequent recurrence of bleeding after drug and endoscopic treatment. TAVI is an effective therapy with an 88% resolution rate.

1. Introduction

Heyde was the first to report 10 patients with severe aortic stenosis (AS) complicated by unexplained gastrointestinal bleeding (GIB) in 1958 and to suspect a correlation between the two. The underlying condition has been termed Heyde syndrome. Greenstein et al. determined the cause of GIB linked to severe AS to be related to angiodysplasia (AD) in 1986. The deficiency of vWF-HMWM was connected to the link between AS and AD by Warkentin et al. in 1992[1]. Cribier et al. performed the first human transcatheter aortic valve implantation (TAVI), describing a less invasive and safe surgical alternative form of treatment in 2002[2], and Gejunbo's team

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carried out the first domestic TAVI operation in October 2010. TAVI technology has continued to develop and patients suffering from severe AS have seen their symptoms improve and vWF-HMWM levels return to normal following TAVI surgery [3]. However, there are few reports on TAVI treatment for HS patients and relevant experience is lacking, although many aortic valve replacement (SAVR) surgeries have been reported. Therefore, the current study analyzed international case reports of HS patients treated with TAVI by collating data from literature databases. Epidemiology, clinical and laboratory characteristics, echocardiography, endoscopy, valve intervention, postoperative efficacy and follow-ups are summarized.

2. Materials and methods

2.1. Literature search

Relevant studies were accessed from PubMed, Web of Science, Embase, Medbooks, CNKI, Chinese Medical Literature Database (CMB), Wanfang and VIP databases. Searches were performed via the following keywords: “Heyde Syndrome or Heyde’s syndrome ", “TAVR or Transcatheter aortic valve replacement ", “Gastrointestinal bleeding or Alimentary tract hemorrhage “and “Angiodysplasia or Gastrointestinal vascular dysplasia ". Keywords were used alone or in combination to identify case reports or letters to the editor and all literature was imported into Endnote for management.

2.2. Literature screening

Two researchers removed duplicates, read titles and abstracts and screened publications according to inclusion and exclusion criteria. Inclusion criteria: Case reports of patients with HS treated with TAVI. Exclusion criteria were as follows: (1) patients <18 years; (2) articles with no case reports, such as meta-analyses, systematic reviews and studies based on animal models; (3) cases reported with SAVR rather than TAVI; (4) case reports with missing critical information. Disagreements between the two researchers were reviewed by a third.

2.3. Summary of literature

The following data was extracted: (1) basic publication information, including author, publication year, reporting country; (2)

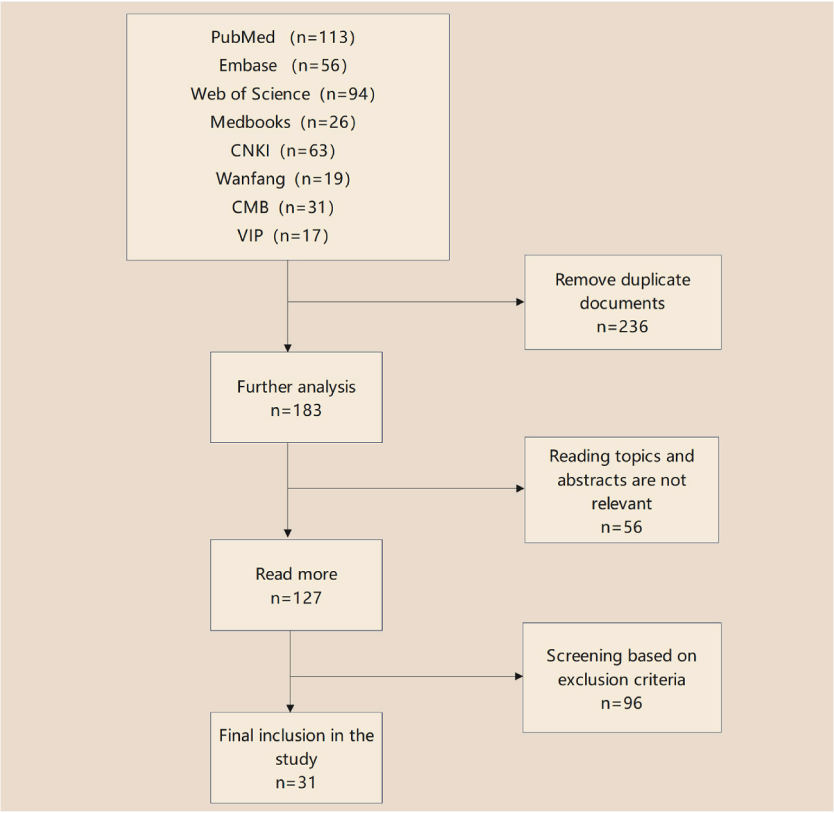

Fig. 1. Literature screening flow chart.

basic HS patient information, including gender, age, clinical manifestations, signs; (3) AS severity, according to valve area, left ventricular ejection fraction (LVEF), aortic valve transmitral pressure gradient, peak systolic velocity; (4) information relating to gastroscopy, enteroscopy and capsule endoscopy (the site of AD); (5) details of treatment plan, including drug, endoscopic therapy, TAVI treatment; (6) measurements pre- and post-surgery, such as hemoglobin, mean pressure gradient across valves, vWF-HMWM); (7) follow-up data, including follow-up time, surgical effect, recurrence of bleeding. The above data are summarized by means of a table (see Table 1).

3. Results

Preliminary searches identified 314 publications, of which 66 were duplicates and 195 did not satisfy the inclusion criteria. 22 articles contained insufficient information for inclusion and the remaining 31 case reports were included (Fig. 1; Table 8).

3.1. Basic information

All case reports were published in the past ten years. Western countries, particularly the United States, used TAVI technology earlier and more skillfully with Asia developing the technique later and reporting relatively few cases.

3.2. Basic HS patient data

The range of patient ages was 56–89 years (mean: 78.2 ± 7.2 years) and the majority were female (67.7%). Elderly patients (≥65 years) accounted for the vast majority (93.5%) and most were over 80 (61.3%). All patients (31/31) had a history of repeated defecation with 15 reporting chest tightness and shortness of breath and 5 having a history of syncope. Cardiac auscultation was reported in 15 cases, all patients (15/15) had systolic murmurs in the second costal auscultation area at the right sternum margin and 9 (9/15) had murmurs conducting to the neck (Table 2).

3.3. Echocardiography

22 cases (22/31) reported severe aortic valve stenosis with an average valve area of 0.64 ± 0.13 cm^2 (range: 0.5–0.9 cm^2). Mean peak flow velocity was 4.76 ± 0.47 m/s (range: 4–5.74 m/s) for 14 patients (14/31) and 13 had an ejection velocity consistent with severe AS. Mean pressure gradient before surgery was 49.1 ± 13.2 mmHg (range: 19–91 mmHg) for 21 patients (21/31) and 15 were classified as having severe AS. Thirteen patients (13/31) had mean transvalvular pressure gradients of 14.7 ± 7.8 mmHg (range: 6–27 mmHg) and all patients (13/13) had significantly decreased transvalvular pressure gradient post-TAVI. These three parameters were used in combination with aortic valve area, mean valve pressure and peak flow velocity to determine the severity of AS stenosis in 29 patients. 1 case (1/29) was determined to have mild AS and 28 (28/29) to have severe AS (96.5%). Left ventricular ejection fraction (LVEF) was 52.1 ± 12.9% (range: 24–71%) in 16 cases, of whom LVEF was maintained in 11 (LVEF ≥50%) and reduced in 2 (LVEF <40%; Table 3).

3.4. Gastroscopy and capsule endoscopy

Recurrent and unexplained GIB is often related to some form of AD in the gastrointestinal tract. All patients of the current cohort had recurrent GIB and 26 (26/31) underwent gastroduodenoscopy, colonoscopy or capsule endoscopy with 22 (22/26) being found to have AD. AD of the duodenum (9/22) and jejunum were the most common (9/22), followed by the ascending colon (6/22), ileum (6/22), multiple sites (3/22), transverse colon (1/22) and stomach (1/22; Table 4).

3.5. Therapeutic schedules

All patients were treated separately or in combination with blood transfusion/octreotide/desmopressin/vWF supplementation before TAVI treatment but showed recurrent bleeding symptoms and no significant improvement (100%). 14 patients (14/31) were

Table 1
Basic information.

Country:	N	Percentage of reported cases (%)
China [1,4]	5/31	16.1
United States [5,6,7,8–11,12,13,14,15,16]	12/31	38.7
United Kingdom [17]	1/31	3.2
Brazil [18,19]	2/31	6.5
Japan [20,21,22,23]	4/31	12.9
Australia [24]	1/31	3.2
Poland [25]	1/31	3.2
Italy [26,27,28,29]	4/31	12.9
Spain [30]	1/31	3.2

Table 2
Basic HS patient data.

	N	Percentage of reported cases (%)
Sex:		
Male	10/31	32.3
Female	21/31	67.7
Age:		
≤65	2/31	6.5
65–80	10/31	32.3
≥80	19/31	61.3
Symptoms.:		
Melena	31/31	100
Chest tightness, shortness of breath	15/15	100
Syncope	5/5	100
Aortic murmur:		
Systolic murmur	15/15	100
Conduction to the neck	9/15	60.0

Table 3
Echocardiograms.

	N	Percentage of reported cases (%)
Aortic valve		Mean ± SD
Area (cm^2)	22/31	0.64 ± 0.13
MPG (mmHg)	21/31	49.1 ± 13.2
PSV(m/s)	14/31	4.76 ± 0.47
LVEF (%)	16/31	52.1 ± 12.9
Postoperativ of MPG (mmHg)	13/31	14.7 ± 7.8

Abbreviation: MPG: mean pressure gradient; PSV: peak systolic velocity; LVEF: left ventricular ejection fraction.

Table 4
Gastroscopy and capsule Endoscopy.

	N	Percentage of reported cases (%)
Angiodysplasia:		
Stomach	1/22	4.5
	9/22	40.9
Jejunum	9/22	40.9
Ileum	6/22	27.3
Ascending colon	6/22	27.3
Transverse colon	1/22	4.5
Multiple sites	3/22	13.6

Table 5
Therapeutic schedule.

	N	Percentage of reported cases (%/Mean ± SD)
Therapeutic schedule:		
Drug therapy:	31/31	100
Transfusion/octreotide/desmopressin/vWF	31/31	100
Relapse	31/31	100
Endoscopic therapy:	14/31	45.2
Electrocoagulation/cauterization/embolization	14/31	45.2
Relapse	14/14	100
TAVI:	31/31	100
Valve size (mm)	11/31	25.3 ± 1.92
Relapse	3/25	12

treated by endoscopy, some with argon electrocoagulation, cauterization of hemorrhagic points or interventional embolization. None of the above treatments completely abolished recurrent bleeding. 31 H S patients received TAVI, mostly involving imported valves, the sizes of which were 25.3 ± 1.92 mm in the 11 cases with reported valve size. Successful TAVI treatment of GIB was reported for 88% of the 25 cases which were followed up (Table 5).

Table 6
Auxiliary examinationsbefore and after TAVI.

	N	Percentage of reported cases (%)
VWF-HMWM:		
Preoperative:		
Reduce	15/17	88.2
Normal	2/17	11.8
Postoperation:		
Return to normal	11/12	91.7
Not return to normal	1/12	8.3
Hemoglobin:		Mean ± SD
Preoperative (g/dl)	26/26	7.3 ± 1.6
Postoperation (g/dl)	12/16	11.2 ± 2.2
MPG of the aortic valve:		Mean ± SD
Preoperative (mmHg)	21/31	49.1 ± 13.2
Postoperation (mmHg)	13/31	14.7 ± 7.8

Abbreviation: vWF-HMWM: high-molecular-weight multimers of von Willebrand factor; MPG: mean pressure gradient.

Table 7
Follow-up after TAVI.

	N	Percentage of reported cases (%)
Follow-up:		Mean ± SD
Time (month)	23/31	9.9 ± 11.8
Symptom improvement	31/31	100
Recurrence of bleeding was	22/25	88
Recurrence of bleeding	1/25	4
Worsening of bleeding	2/25	8

3.6. Auxiliary examinations before and after TAVI

Fifteen out of 17 reports found deficient or decreased vWF-HMWM prior to TAVI and 2 were normal. Post-TAVI vWF-HMWM levels had returned to normal in 11/12 reported cases and remained abnormal in 1 case. All patients (31/31) had experienced recurrent GIB in the past and 27 (27/31) had low hemoglobin before TAVI (mean = 7.3 ± 1.6 g/dl), including 3 with mild anemia (lower than normal but >9 g/dl), 19 with moderate anemia (6–9 g/dl) and 4 with severe anemia (<3 g/dl). There were 16 reports of enhanced hemoglobin status following surgery with 12 patients having a mean hemoglobin of 11.2 ± 2.2 g/dl and 4 being stable and normal. A mean pressure gradient pre-surgery was 49.1 ± 13.2 mmHg for 21 patients (21/31) and post-surgery 14.7 ± 7.8 mmHg for 13 patients (13/31; Table 6).

3.7. Follow-up after TAVI

Follow-up times of 0.5–48 months were recorded for 23 patients (23/31). All patients (31/31) had improved postoperative clinical symptoms and 22 (22/25) had no further bleeding during follow-up (88%). Two patients (2/25) had new vascular dilatation and repeated GIB after TAVR which continued to worsen in 1 patient (1/25). Post-TAVR hemorrhage recurrence rates were 12% (Table 7).

4. Discussion

Hyde syndrome (HS) is rare and involves gastrointestinal bleeding (GIB) due to aortic stenosis (AS), angiodysplasia (AD) and deficiency of acquired von Willebrand factor (vWF). It occurs mainly in the elderly (≥65 years) and both prevalence and severity of AS increase with age. Previous studies have shown moderate to severe AS in 1.8% of the population over 75 years [31], and the current study found 45% prevalence of severe AS among female HS patients over 80 years. The longer life expectancy of women compared with men contributes to the increased likelihood of AS developing. The pathophysiology of HS may be explained as follows. High shear stress generated by AS facilitates the degradation of high-molecular-weight multimers of von Willebrand factor (vWF-HMWM) by the protease, ADAMTS13, affecting platelet adhesion to vascular lesions, resulting in bleeding. Deficiency of vWF causes gastrointestinal AD and the resulting malformed blood vessels are easily ruptured. Indeed, the degree of vWF-HMWM loss is negatively correlated with the severity of AS. It has been estimated that 32% of patients with gastrointestinal arteriovenous malformation (AVM) experience AS while 68% do not [32] [32]. vWF de-aggregation is significant at a mean aortic valve cross-valve pressure difference of more than 40 mmHg and acquired vWF reduction is about 67% in patients with severe AS while 33% have normal vWF levels [33]. Two patients of the current cohort (11.8%) had normal vWF-HMWM levels and 4 (18.2%) had no observable abnormalities on gastroenterological examination. Therefore, normal vWF results and recurrent GIB without typical AD by endoscopy do not exclude the possibility of HS.

No clear guidelines or expert consensus on HS treatment exist and the presence of GIB, AS and acquired von Willebrand disease

Table 8
Summary of all case reports.

Studies	Country	Date	Age	Sex	angiodysplasia	①HB (g/L)	②HB (g/L)	①MPG mmHg	②MPG mmHg	①AVA cm2	①PSV m/s	①LVEF %	TAVI mm	follow-up time
García Martínez, A.et al. [30]	Spain	2022	82	F	Duodenum, jejunum, ileum	NR	NR	NR	NR	NR	NR	NR	NR	3
Dahiya, D. S. et al. [7]	USA	2021	61	M	Normal	8	NR	NR	NR	0.65	0.65	65	23	36
Amaral, L. T. W. et al. [18]	Brazil	2021	86	F	Duodenum	NR	NR	52	NR	0.7	0.7	NR	NR	NR
Chukwudum, C. A. et al. [8]	USA	2020	73	F	Duodenum, jejunum, ileum	5.2	8.9	NR	NR	0.8	0.8	50	NR	0.5
Tsuchiya, S. et al. [20]	Japan	2020	83	F	stomach	7.6	NR	81	10	0.5	0.5	60	23	24
Alshuwaykh, O. et al. [9]	USA	2018	56	F	Normal	6.7	14.3	35	24	0.76	0.76	NR	NR	6
Song, A. B. et al. [6]	USA	2021	72	F	Duodenum, jejunum, ileum	6.4	Normal	62	NR	0.8	0.8	NR	NR	10
Abdelmaseih, R. et al. [10]	USA	2022	74	M	NR	6.2	13.6	56	6	0.59	0.59	NR	26	6
Ramachandran, R. et al. [11]	USA	2018	85	M	jejunum	NR	NR	37	NR	0.6	0.6	NR	NR	6
Rashid, S. et al. [17]	UK	2016	86	F	Gastrointestinal tract	8.4	Normal	55	26	0.5	0.5	NR	26	3
Omar Then, E. et al. [12]	USA	2019	84	F	Duodenum, jejunum, ileum	5.1	NR	19	NR	NR	NR	NR	NR	NR
Dweik, A. et al. [13]	USA	2022	86	F	Ascending colon	7	NR	NR	NR	NR	NR	NR	NR	NR
Godino, C. et al. [26]	Italy	2012	83	F	Duodenum	6.1	Normal	58	27	0.7	0.7	NR	23	6
Abe, D. et al. [21]	Japan	2020	84	F	NR	6.8	Normal	55	NR	0.5	0.5	71	NR	1
Hudzik, B. et al. [25]	Poland	2016	82	M	NR	9.5	NR	37	NR	0.7	0.7	24	NR	12
Balbo, C. P. et al. [19]	Brazil	2017	81	M	Ascending colon	6.4	NR	35	NR	0.9	0.9	32	NR	6
Famularo, G. et al. [27]	Italy	2020	80	F	jejunum	7.7	10	NR	NR	NR	NR	NR	26	3
Ahmed, T. et al. [14]	USA	2020	79	M	NR	9	NR	37	6	0.9	0.9	NR	NR	NR
Wang, B. et al. [1]	China	2016	84	F	Ascending colon, Transverse colon	6.9	7.9	57	15	NR	NR	50	23	48
Huang, D. J. et al. [4]	China	2016	74	F	Normal	6.5	NR	NR	NR	NR	NR	45	NR	NR
Sugimoto, S. et al. [22]	Japan	2022	82	M	Normal	10.6	12.1	42	NR	0.5	0.5	NR	NR	4
Fukuhara, K. et al. [23]	Japan	2019	80	F	NR	11.8	NR	NR	14	0.55	0.55	65	NR	NR
Obeidat, A. E. et al. [15]	USA	2021	70	M	Duodenum, jejunum	5.9	NR	52	11	0.7	0.7	55	NR	NR
Benton, S. M. et al. [16]	USA	2014	77	M	Ascending colon	NR	NR	62	23	NR	NR	55	26	10
Pyxaras, S. A. et al. [28][1]	Italy	2012	89	F	Gastrointestinal tract	8.6	13.3	44	NR	0.56	0.56	60	26	6
Mirna, M. et al. [24]	Austria	2019	73	F	ileum	6.5	13.5	NR	NR	0.8	0.8	NR	29	NR
Yang, Y.J. et al.	China	2021	82	M	Ascending colon	7.4	12	53	6	NR	NR	40	27	12
Shi, X.X. et al.	China	2021	75	F	Ascending colon	5.8	NR	NR	NR	0.8	0.8	55	NR	12
Cheng,S. et al.	China	2021	80	F	Duodenum, jejunum, ileum	NR	9.2	52	13	NR	NR	42	26	1
Dall'Ara, G. et al. [29]	Italy	2021	82	F	Duodenum, jejunum	6.6	9.5	50	10	0.55	0.55	NR	NR	3
Virk, Z. M. et al. [5]	USA	2022	78	F	Gastrointestinal tract	NR	9.7	NR	NR	NR	NR	NR	NR	NR

Abbreviation: HB: Hemoglobin; MPG: Mean pressure gradient; AVA: Aortic valve orifice area; PSV: Peak systolic velocity; F: Female; M: Male; NR: Not reported; LVEF: Left ventricular ejection fraction; TAVI: Transcatheter aortic valve replacement; ①Preoperative; ②Postoperation.

(AVWS) inform therapeutic strategies. HS often manifests as recurrent GIB caused by gastrointestinal AD. Digestive tract endoscopy often produces promising hemostatic effects in the initial stages but the recurrence rate is high. A meta-analysis showed that post-endoscopy hemorrhage recurrence rates in 490 patients with AD-related GIB were comparable to those of patients who did not receive endoscopy during 2 years of follow-up (42.7%vs49.2%) [34]. VWF-deficient AVWS is a characteristic of HS and vWF/FVIII supplements; desmopressin and fresh frozen plasma are usually ineffective. However, preoperative decompression for patients with severe AS has been shown to reduce bleeding by 42% following SAVR [35]. The current cohort of 31 patients was treated with a combination of blood transfusion/vWF/FVIII supplement, endoscopic cauterization and hemostasis, argon plasma coagulation (APC), endovascular embolization and combined drugs prior to TAVI. Treatments produced improvements in symptoms in the initial stages but GIB recurred in 100% of cases.

AS underlies all the above clinical manifestations of HS patients. Surgical valve replacement (SAVR) is a powerful treatment tool for HS, controlling gastrointestinal bleeding better than intestinal surgery and drug therapy alone [36], although the operation carries a high risk and postoperative complications may occur. By contrast, TAVI requires a short operation time, causes less vascular damage and blood loss and achieves a higher success rate. TAVI corrects AS, removing the root cause of abnormal clotting in HS and intestinal AD. This approach is suitable as a first choice for treatment of patients with severe AS who cannot receive SAVR. Numerous studies have demonstrated no statistical difference in in-hospital mortality among high-risk patients receiving TAVI compared with SAVR. No difference in efficacy for middle-risk patients was found and bleeding recurrence rates, total length of hospital stay and mortality were significantly lower among patients receiving TAVR compared with SAVR (10.4% vs 43.4%). TAVI has been shown to be no less effective than SAVR, even in low-risk patients, and TAVI produces fewer intraoperative complications, such as myocardial infarction and stroke and fewer postoperative complications [37,38]. Godino et al. found that HS patients who successfully received TAVI had no recurrence of GIB during 2 years of follow up [39]. Tsuchiya et al. reported complete post-surgery GIB remission in 31/37 H S cases (83.8%) successfully receiving SAVR or TAVI [20]. Spangenberg et al. have also reported restoration of vWF-HMWM levels following TAVI in 95 patients [40]. The reduction in vWF-HMWM has recently been shown to resolve within minutes or hours after TAVI treatment [41]. Most of the current HS patients were elderly and had severe AS with many underlying diseases and bleeding tendencies, rendering tolerance of surgery low and informing a choice of TAVI. Goltstein et al. ahve rpeviosuly shown that 62% of TAVI-treated HS patients had complete resolution of GIB in the first year after surgery and 83% did not have further GIB during the 5-year follow-up[[42]]. The current findings are in line with previous literature. TAVI success rates were superior (31/31) and with high postoperative correction (22/25). Postoperative hemoglobin was increased and stable and mean postoperative aortic pressure gradient reduced from 49.1 ± 13.2 mmHg to 14.7 ± 7.8 mmHg. Follow-up showed restoration of vWF factor in 91.7% of patients, most within 1 week, and decreased GIB recurrence. AD disappeared after TAVI in most cases but 2 had new gastrointestinal vascular dilatation. A retrospective analysis of 482 hospitalized TAVI patients found that only 1.4% developed GIB immediately after TAVI and a second study of 372 patients who received TAVI reported that up to 11.3% developed GIB [43]. Waldschmidt et al. also showed that GIB recurrence rates in HS patients can be as high as 39.8% during 12-month postoperative follow-up[[44]]. Therefore, it remains to be investigated whether the presence of new postoperative gastrointestinal vasodilatation is associated with recurrent GIB.

The outcome of GIB after TAVI may be influenced by a variety of factors, including the dosage and duration of antiplatelet drugs/anticoagulants, age and complications. AD was found to resolve in most patients after TAVI but 2 cases were reported to have new gastrointestinal vascular dilatation and we speculate that an unknown pathophysiological mechanism may be responsible. The two patients in question were treated with systemic bevacizumab anti-angiogenesis therapy, which relieved but did not abolish recurrent bleeding, and 5 mg/kg bevacizumab was given every 4 weeks for an indefinite period [5,6]. HS patients sometimes experience persistent bleeding or new vascular dilatation despite receiving TAVI. Systemic bevacizumab may be helpful in the treatment of these challenging cases but further research is necessary to establish full etiology. Thromboembolism and paravalvular leakage are also common problems following TAVR surgery but most case reports did not mention such problems.

TAVI is becoming the mainstream alternative surgical therapy for AS but data relating to HS patients and clear guidelines with expert consensus are lacking. Recurrent and uncontrollable GIB may be the most frequent indication for TAVI treatment of HS patients [45]. Most pre-existing literature supporting TAVI treatment for HS came from case reports and retrospective studies. Systematic review revealed difficulties in calculating time from symptom onset to diagnosis and treatment but therapy was often challenging, leading to delay and the risk of missing the optimal treatment time, increasing length of hospital stay and risk of death. HS clinical manifestations often span the specialist disciplines concerning digestive, cardiovascular and blood systems, requiring clinicians to transcend specialisms to improve the understanding and knowledge of HS and patients' long-term prognoses. The main limitation of this study is the small number of cases included and future in-depth studies are needed to develop guidelines for TAVI treatment of HS and improve diagnoses and treatment outcomes.

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Author contributions

Concept and Design: Lilan Wang. Document retrieval: Lilan Wang, Xin Su, Weimin Wang, Weimei Ou. Data acquiring and analysis system: All authors. Draft the of manuscript: Lilan Wang, Weimin Wang, Qiaoru Xu. Modify important content: Bin Wang; Syntax check: Xin Su. Statistical chart: Kaimin Wu, Guangfeng Sun. Technical and material support: Bin Wang; Essay Writing: All authors.

Modification comments

1. The purpose of the study has been modified.

2. Inclusion criteria have been added.

3. Two large studies on HS and TAVI were not included in this study because the subjects of this study were case reports of TAVI treatment in HS patients from different countries. The results of the two studies have been described and analyzed in detail in the discussion section of this study.

4. Both data support and major limitations of the study findings were added.

1.Previous studies on TAVI treatment in HS patients were mostly single-center studies, but the present study only included case reports, but involved reports of TAVI treatment in HS patients from numerous countries, which may provide valuable suggestions for the treatment protocols of HS patients in the whole human population. Therefore, future studies with samples from multiple centers may be conducted to provide further constructive advice for the treatment of this patient population.

2.Numerous studies have indicated that there is no statistically significant difference in in-hospital mortality between high-risk patients receiving TAVI or SAVR; there is also no significant difference in outcomes between intermediate-risk patients receiving TAVI or SAVR, and bleeding recurrence rates, total length of hospital stay, and mortality are significantly lower in the TAVR-treated group than in SAVR (10.4% vs. 43.4%); recent studies have also shown that even in low-risk surgical patients TAVI treatment outcomes are not inferior to SAVR even in low-risk patients, and TAVI has been shown to have fewer perioperative complications, including myocardial infarction, stroke, and postoperative complications, compared with SAVR. In addition, TAVI technology has been rapidly developed in recent years, and compared with surgical procedures, it is characterized by shorter operative time, less intraoperative access vascular damage, less intraoperative blood loss and higher success rate, and it can also immediately relieve AS and remove the underlying causes of HS coagulation abnormalities and intestinal AD, which can be the treatment of choice for patients with severe AS who cannot undergo SAVR. Therefore, in the future, we can focus on the treatment of HS patients with TAVI, which may benefit patients with severe AS who are elderly, have more underlying diseases and bleeding tendency, cannot tolerate surgery and have high surgical risk.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e17952.

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