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Survival and clinical success of endovascular intervention in patients with Budd-Chiari syndrome: A systematic review

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ABSTRACT

Budd-Chiari syndrome is a complex clinical disorder of hepatic venous outflow obstruction, originating from the accessory hepatic vein (HV), large HV, and suprahepatic inferior vena cava (IVC). This disorder includes both HV and IVC obstructions and hepatopathy. This study aimed to conduct a systematic review of the survival rate and clinical success of different types of endovascular treatments for Budd-Chiari syndrome (BCS). All participant studies were retrieved from four databases and selected according to the eligibility criteria for systematic review of patients with BCS. The survival rate, clinical success of endovascular treatments in BCS, and survival rates at 1 and 5 years of publication year were calculated accordingly. A total of 3398 patients underwent an endovascular operation; among them, 93.6% showed clinical improvement after initial endovascular treatment. The median clinical success rates for recanalization, transjugular intrahepatic portosystemic shunt (TIPS), and combined procedures were 51%, 17.50%, and 52.50%, respectively. The median survival rates at 1 and 5 years were 51% and 51% for recanalization, 17.50% and 16% for TIPS, and 52.50% and 49.50% for combined treatment, respectively. Based on the year of publication, the median survival rates at 1 and 5 years were 23.50% and 22.50% before 2000, 41% and 41% in 2000–2005, 35% and 35% in 2006–2010, 51% and 48.50% in 2010–2015, and 56% and 55.50% after 2015, respectively. Our findings indicate that the median survival rate at 1 and 5 years of recanalization treatment is higher than that of TIPS treatment, and recanalization provides better clinical improvement. The publication year findings strongly suggest progressive improvements in interventional endovascular therapy for BCS. Thus, interventional therapy restoring the physiologic hepatic venous outflow of the liver can be considered as the treatment of choice for patients with BCS which is a physiological modification procedure.

Keywords: Budd-Chiari syndrome, Endovascular interventional treatment, Survival rate, systematic review recanalization, Transjugular intrahepatic portosystemaic shunt

INTRODUCTION

Budd-Chiari syndrome (BCS) is a complex clinical disorder of hepatic venous outflow obstruction, originating from the accessory hepatic vein (HV), large HV, and suprahepatic inferior vena cava (IVC).[1] This disorder includes both HV and IVC obstructions and hepatopathy.[2] Partial or complete obstruction of the IVC with membranous or segmental lesions was considered to be the main cause of BCS in Asian countries.[3] The membranous obstruction of the IVC contributes to two-thirds of patients with BCS in Asia.[4] Most patients with BCS present late after developing symptoms or in their chronic conditions, whereas only a small number of patients present with an acute and fulminant type of BCS.[5] BCS is more commonly seen in adults than in children;

when seen in children, clinical manifestations are similar to those in adults.[6] Endovascular intervention treatment has emerged as an advanced therapeutic option for patients with BCS. Transjugular intrahepatic portosystemic shunt (TIPS) procedures have rapidly replaced the traditional surgical shunt on account on their due to minimal invasiveness, low blood loss, low infection rate, quick recovery, shorter hospital stay, and increased long-term survival rate.[7,8] TIPS significantly reduced portal venous pressure through placement of an artificial stent from the portal vein to the HV. The patency of shunts has greatly improved since the adoption of dedicated polytetrafluoroethylene stents.[9] Recanalization is a physiological procedure that maintains natural blood flow in the HV/IVC.[10] It can minimize the risk of hepatic encephalopathy, and remains a first-line treatment option for patients with BCS.[11,12] One-third of short-length HV stenosis was treated with recanalization by percutaneous transluminal angioplasty (PTA) with or without stent placement.[13,14] Recanalization has shown promising results in Asian countries with excellent clinical outcomes and higher survival rates.[15] The European Association for the Study of the Liver recommended a stepwise therapeutic algorithm for BCS. The algorithm depends on treatment response, medical therapy with anticoagulant drugs, angioplasty, stent placement, TIPS, and liver transplantation.[16] The prognosis of patients with BCS depends on the onset of obstruction in vessels with anatomical location and liver dysfunction. However, new developments and improvements in radiological endovascular therapy and early diagnosis have increased the survival rate of patients with BCS.

The present systematic review aimed to evaluate the survival rate of BCS after different types of endovascular intervention, clinical success after initial different types of endovascular intervention treatment, and survival rate of BCS in the publication year.

METHODS

Search strategy

Relevant studies were searched in PubMed, Science Direct, Cochrane Library, and EMBASE databases, and the necessary data were retrieved. The last search was performed on February 17, 2021. Our search items included the following: Budd-Chiari syndrome, HV obstruction, or hepatic venous thrombosis, endovascular treatment in BCS or interventional treatment in BCS, PTA for BCS, TIPS for BCS, or transjugular intrahepatic portosystemic shunting for BCS.

Data selection

All published articles met the eligibility criteria according to the population, interventions, comparison, outcomes, and study results. The study selection process was demonstrated in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis guidelines [Figure 1].

The inclusion criteria were: (1) Retrospective studies, prospective studies, including case-control studies were eligible; (2) all the previous studies reporting the survival rate and clinical success; (3) full article papers with detailed information and statistical results of intervention treatment; and (4) there were no publication data, publication language, or publication status restrictions.

Exclusion criteria were: (1) Duplicate studies; (2) studies that were not original papers; (3) studies unrelated to the subject matter of this review; (4) case reports; (5) comments; (7) essays; (8) abstracts; (9) not reporting relevant clinical outcomes; (10) lack of details results; (11) review articles; (12) fewer than ten patients; (13) studies unmatched inclusion criteria; and (14) studies with missing survival rate, re-intervention rate, and clinical success.

Data extraction

In a data extraction sheet, information regarding the first author, publication year, country, number of patient participants in individual studies, sex, mean age, type of endovascular treatment, clinical success rate, total follow-up, and survival rate at 1 and 5 years after initial endovascular treatment was extracted for further analysis.

Quality assessment

Studies were considered to be of higher quality if they fulfilled all the following predetermined criteria: (1) Patients were admitted to the hospital consecutively; (2) the interval of enrollment and eligibility criteria was recorded; (3) the length of follow-up and number of deaths were reported; (4) patients were diagnosed with BCS and treated with endovascular intervention procedures; and (5) survival analysis and clinical success were reported.

Definition

HV Angioplasty/Stenting: When the stiff guide wire was established, a balloon dilator catheter of 12–15 mm diameter was inserted from the right jugular vein puncture site to the obstructed part of HV through the guide ware. Next, the balloon catheter was dilated twice, and each dilatation occurred 40s. If there was more than 30% residual stenosis on HV venography after balloon dilated then a stent was inserted in the stenosis part of the HV.

IVC Angioplasty/Stenting: Venography was performed to evaluate the IVC anatomy and obstruction characteristics. Next, a guide wire with a balloon catheter (25-30mm) was used to dilatation IVC stenosis parts. A self-expandable metallic stent was used if the IVC narrowed immediately

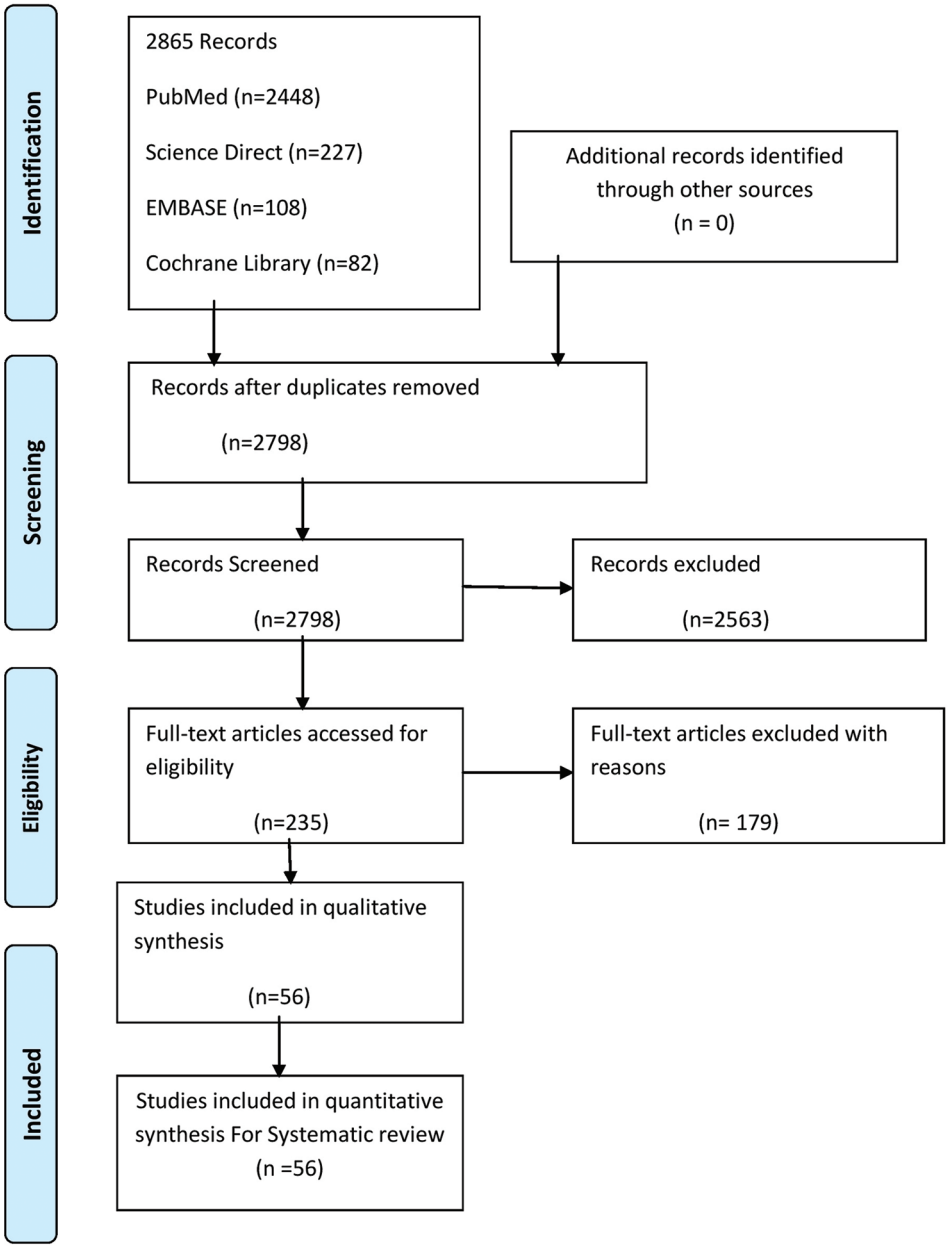


Figure 1: Preferred reporting items for systematic reviews and meta-analysis flow diagram of studies selection process.

after dilated or more than 30% residual stenosis on IVC venography after balloon dilation.

Recanalization

It was performed with balloon dilation or endovascular stent placement in the stenosis part of HV and IVC.

TIPS/direct intrahepatic portosystemic shunt (DIPS)

It was performed in symptomatic patients with non-recanalization HV obstruction, portal hypertension, refractory ascites, variceal bleeding, and long segment obstruction HV. DIPS usually used in failed TIPS, occluded three major HVs and anomalies of HVs.

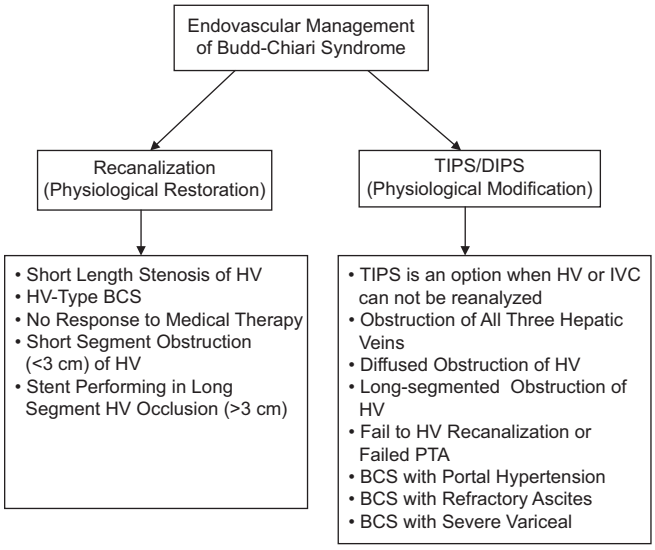
Technical success

Technical success of recanalization was defined as the complete elimination of HV or IVC obstruction and confirmed by venography. Technical success of TIPS was defined as the successful placement of an artificial stent between the HV and the portal vein. The stent position was

confirmed by angiography, and the contrast medium flowed back into the right atrium smoothly through the intrahepatic shunt.

Data analysis

We summarized the 1- and 5 years survival rates according to different types of endovascular intervention treatment mortalities and publication years in an Excel worksheet. Then, a box plot was drawn to describe the median survival rate with range using SPSS software (version 16.0; SPSS, Chicago, IL, USA).



Flow chart of indication of the endovascular management in BCS

RESULTS

Overview on basic characteristics of the included studies

Overall, 2865 articles were retrieved, of which 56 studies with complete information regarding the survival rate and clinical success of the endovascular intervention in patients with BCS patients were included in the final systematic review.[8,10,11-13,17-68] All selected studies were published between 1995 and 2019. Of these, 40 individual studies were published after 2010. Twenty-seven studies were conducted in China, whereas 29 studies were conducted outside China. The basic characteristics of these studies are summarized in [Tables 1 and 2].

A total of 3398 patients underwent endovascular intervention; among them, 93.6% achieved clinical improvement after initial interventional endovascular treatments. Recanalization was used in 26 studies, TIPS in 14 studies, and combined procedures in 16 studies [Table 1]. According to the follow-up duration, 56 studies recorded a follow-up period of more than 60 months, 31 studies of 96 months, and 19 studies for more than 120 months [Table 1].

Study quality

Patients were consecutively admitted to the hospital in 54 (96.42%) studies. From the total 56 studies, 51 (91.07%) studies were considered to be of good quality whereas five (8.92%) were of poor quality. The interval between enrollment and eligibility criteria was recorded for all the included studies. All patients were diagnosed with BCS and treated with endovascular intervention procedures accordingly. Fifty-one studies showed a good survival rate, and only five showed a moderate survival rate at 1 year. Similarly, 40 studies had good survival rates, 15 studies had moderate survival rates, and only a single study had a poor survival rate at 5 years [Table 1].

Clinical success in different types of interventional endovascular procedures

The overall clinical success rate of endovascular intervention in patients with BCS was 93.6%. The median clinical success of recanalization procedures was 51% (range: 32–70%) in 26 studies, in which the patients were treated with angioplasty with or without stent; for the combined procedures was 55.50% (range: 31–79%) in 16 studies, in which patients were treated with recanalization (angioplasty with or without stent) and TIPS. TIPS procedure was 18.50% (range: 14–53%) in 14 studies, where patients were treated with TIPS [Figure 2].

Survival rate at 1 year in different types of interventional endovascular procedures

The total survival rate at 1 year of endovascular treatment in 56 studies was 96.9%, whereas the median survival rate at 1 year of recanalization was 51% (range: 31–70%) in 26 studies treated with angioplasty with or without stent placement. Similarly, the median survival rate at 1 year of combined procedures was 52.50% (range: 29–71%) in 16 studies using angioplasty, stent, and TIPS; and 17.50% (range: 13–51%) in 14 studies using TIPS [Figure 3].

Survival rate at 5 years in different types of interventional endovascular procedures

The total survival rate at 5 years of endovascular treatment in 56 studies was 93.3%, whereas the median survival rate at 5 years of recanalization was 51% (range: 31–66%) in 26 studies treated with angioplasty with or without stent placement. Similarly, the median survival rate at 5 years of combined procedures was 49.50% (range: 29–70%) in 16 studies using recanalization (angioplasty, stent) and

Table 1: Baseline characteristic of included studies.

S. No.	Studies characteristics	Number		Percentage	
1.	Total previous studies retrieved	56		100	
2.	Publication year between (1995 and 2019)				
3.	Last search performed – 17-02-2020				
4.	Publication year studies				
	<2000	4		7.1	
	2000–2005	7		12.5	
	2006–2010	5		8.9	
	2011–2015	18		32.1	
	2016–2019	22		39.2	
5.	Region conducted study				
	Eastern Asia (China, and Japan)	28		50	
	Oceania (Australia)	1		1.7	
	South Central Asia (India)	7		12.5	
	Middle East (Egypt, Turkey and Saudi Arabia)	3		5.3	
	Europe (UK, Germany, Italy, France, Netherland, Greece , Sweden, and Denmark)	15		26.7	
	North America (USA)	2		3.5	
6.	Type of endovascular treatment				
	Recanalization (PTA with or without stent)	26		46.4	
	Combined (Recanalization and TIPS)	16		28.5	
	TIPS	14		25	
7.	Total patient attempted endovascular procedure	3398		100	
8.	Total Technical successful endovascular procedures	3321		97.7	
9.	Total clinical successful after initial endovascular treatment	3109		93.6	
	>90–100%	45		80.35	
	70–90%	9		16.07	
	<70	2		3.57	
10.	Median clinical success				
	Recanalization			51	
	TIPS			18.50	
	Combined procedures			55.50	
11.	Survival rate				
	At 1 year	3220		96.9	
	At 5 years	3099		93.3	
	>90–100% - Good survival rate	1 yr	5 yrs	1 yr	5 yrs
	70–90% - Moderate survival rate	51	40	91	71.4
	<70 - Poor survival rate	5	15	8.9	26.7
		0	1	0	1.7
12.	Median survival rate			1 yrs	5 yrs
	Recanalization			51	51
	TIPS			17.50	16
	Combined procedures			52.50	49.50
	Survival rate of publication year				
	<2000			23.50	22.50
	2000–2005			41	41
	2006–2010			35	35
	2011–2015			51	48.50
	>2015			56	55.50
13.	Follow-up				
	12 months	56		100	
	>60 months	56		100	
	>96 months	31		53.4	
	>120 months	19		32.7	

PTA: Percutaneous transluminal angioplasty, TIPS: Transjugular intrahepatic portosystemic shunt

Table 2: Included studies.

1st author/Years of published/Reference	Country	N.P	M/F	Mean Age	Stents		Type of Treatment			
					Name	Company	Recanalizetion	TIPS/ DIPS	Stent	Angio
Zahn *et al.*, 2010[8]	Germany	13	3/10	14–60	Palmaz Self-expandable Covered Viatorr stent	Jonhson and Jonhson USA Wallstent Schneider, Bülach, Switzerland GORE, Flagstaff, AZ, USA	---	13	---	---
Rössle *et al.*, 2004[10]	Germany	35	8/27	12–74	Palmaz Self-expandable Memotherm stent Sinus stent Covered Viatorr stent	Jonhson and Jonhson USA Wallstent Schneider, Bülach, Switzerland Angiomed, Karlsruhe, Germany Optimed, Ettlingen, Germany Gore Medical, Munich, Germany	---	33	---	---
Pavri *et al.*, 2014[17]	USA	21/47	16/31	31–69	N/A	N/A	---	21	---	---
Mahmoud *et al.*, 1995[18]	UK	44	17/27	14–60	N/A	N/A	11	---	3	8
Rosenqvist *et al.*, 2016[19]	Sweden	13	6/7	16–63	Covered Viatorr stent	Gore Medical, USA	---	13	---	---
Tripathi *et al.*, 2014[20]	UK	67	21/46	15–70	Covered Viatorr sten Uncovered stent Uncovered metal stent	GORE, Flagstaff, AZ, USA Wallstent® Boston Scientific, Natick, MA, USA Memotherm, Angiomed, Karlsuhe, Germany	---	67	---	---
Sonavane *et al.*, 2018[21]	India	42	26/16	19–68	N/A	N/A	---	42	---	---
Hayek *et al.*, 2016[22]	France	54	20/34	15–67	Covered self-expandable Uncovered stent Covered stent graft viatorr	Wallgraft, Boston Scientific; Fluency, Bard Incorporated, Karlsruhe, Germany Wallstent, Boston Scientific. GORE, Flagstaff, AZ, USA	---	53	---	---
Shalimar *et al.*, 2017[23]	India	80	40/40	12–50	Covered Viatorr sten Uncovered stent Covered stent	GORE, Flagstaff, AZ, USA GORE, Flagstaff, AZ, USA Fluency plus; BARD Inc	---	80	---	---
Murad *et al.*, 2007[24]	Netherland	17	10/6	19–50	Covered Viatorr sten Self-expandable Bare stents	GORE, Flagstaff, AZ, USA Wallstent, Boston Scientific, Natick, MA, USA	---	16	---	---
Molmenti *et al.*, 2005[25]	USA	11	5/6	22–78	Uncovered	Wallstent, Boston Scientific, Natick, MA, USA	---	10	---	---

(Contd...)

Table 2: *(Continued).*

1st author/Years of published/Reference	Country	N.P	M/F	Mean Age	Stents		Type of Treatment			
					Name	Company	Recanalizetion	TIPS/ DIPS	Stent	Angio
Garcia-Pag *et al.*, 2008[26]	Italy	133	78/46	35–40	Uncovered stent (61) Covered stent (48) Both stent (15)	N/A	---	124	---	---
Fitsiori *et al.*, 2013[27]	Greece	14	3/11	3–66	Bare metal stent E-Polytetrafluoroethylene stent graft	N/A GORE, Flagstaff, AZ, USA	---	14	---	---
Neumann *et al.*, 2013[28]	Denmark	14	3/11	17–66	Uncovered stent (10) Covered stent (4)	N/A	---	14	---	---
Corso *et al.*, 2008[29]	Italy	15	7/8	7–52	Self-expandable metallic stents (8) Covered stent graft (7)	Wallstent, Boston Scientific, Watertown, WI, USA, Viatorr Endoprothesis, W.L. Gore Medical, Flagstaff, AZ, USA	---	15	---	---
Kathuri *et al.*, 2014[30]	India	25	16/9	2–16	N/A	N/A	25	---	20	5
Khuroo *et al.*, 2005[31]	Soudi arabia	16/40	17/23	15–64	Self-expandable stent	Wallstent, Boston Scientific, Watertown, WI, USA	6	8	---	6
Jagtap *et al.*, 2017[32]	India	88	52/36	20–56	N/A	N/A	75	0/13	64	73
Amarapurkar *et al.*, 2008[33]	India	38/49	24/25	1–57	Uncovered stent Covered stent	N/A N/A	22	15	22	2
Mo *et al.*, 2017[34]	Australia	27	11/14	21–76	N/A	N/A	11	18	11	11
Zhang *et al.*, 2013[35]	China	18	15/3	19–50	N/A	N/A	15	3	---	15
Meng *et al.*, 2016[36]	China	55	39/14	NA	Bare stents Fluency covered stent	N/A BARD Peripheral Vascular, Inc., Tempe, Arizona	53	5	47	53
Rathod *et al.*, 2016[37]	India	190	102/88	15–55	Covered stent grafts Niti-S TIPS stent Fluency stent graft	Viatorr, W. L. Gore and associates, Arizona, USA Taewoong Medical Co. Ltd., S.Korea Bard Peripheral Vascular, Inc., Arizona, USA	84	106	84	78
Bi *et al.*, 2018[38]	China	60	48/12	12–76	Bare stent E-Luminexx stent Covered fluency stents	Bard Peripheral Vascular, Tempe, Arizona Bard Incorporated, Karlsruhe, Germany	31	27	---	31

(Contd...)

Table 2: *(Continued).*

1st author/Years of published/Reference	Country	N.P	M/F	Mean Age	Stents		Type of Treatment			
					Name	Company	Recanalizetion	TIPS/ DIPS	Stent	Angio
Al-Warraky *et al.*, 2015[39]	Egypt	103	30/73	14–44	Uncovered Covered	Wallshunt, Watertown, WI, USA Gore medical, Flagstaff, AZ, USA	26	55/22	---	26
Eapen *et al.*, 2005[40]	UK	61	22/39	16–67	N/A	N/A	32	29	8	24
Fan *et al.*, 2016[41]	China	60	27/33	18–60	Bare metal stent Stent-Graft	N/A N/A	27	33	---	27
Seijo *et al.*, 2013[42]	Europe	70	NA	16–83	N/A	N/A	8	62	---	8
Bi *et al.*, 2018[43]	China	40	32/8	28–76	N/A	N/A	40	3	2	40
Cui *et al.*, 2015[13]	China	17	8/6	25–66	N/A	N/A	14	---	2	12
Xue *et al.*, 2009[44]	China	53	39/14	11–70	N/A	N/A	47	2	34	13
Ding *et al.*, 2018[45]	China	108	69/39	25–74	N/A	N/A	107	---	13	94
Xu *et al.*, 1996[46]	China	32	6/26	20–56	N/A	N/A	31	---	17	20
Zhou *et al.*, 2017[47]	China	47	33/14	21–71	N/A	N/A	61	---	---	61
Yang *et al.*, 2019[48]	china	33	16/17	44–74	N/A	N/A	33	---	15	18
Huang *et al.*, 2016[49]	China	265	131/134	18–79	N/A	N/A	263	---	56	263
Chen *et al.*, 2017[11]	China	68	39/29	22–52	N/A	N/A	68	---	8	60
Sang *et al.*, 2014[50]	China	48	31/17	25–65	N/A	N/A	43	---	31	43
Srinivas *et al.*, 2012[51]	India	12	7/5	28–55	N/A	N/A	12	---	5	7
Qiao *et al.*, 2005[52]	China	44	25/19	19–77	N/A	N/A	45	---	45	---
Bi *et al.*, 2018[53]	China	72	43/29	22–76	N/A	N/A	91	---	---	91
Zhang *et al.*, 2003[54]	China	115	65/50	17–67	N/A	N/A	122	---	122	---
Tripathi *et al.*, 2016[55]	UK	63	27/36	15–55	N/A	N/A	63	---	31	32
Ding *et al.*, 2015[56]	China	93	59/34	15–72	N/A	N/A	93		2	93
Fu *et al.*, 2011[57]	China	18/29	13/16	23–67	N/A	N/A	22	---	---	22
Cheng *et al.*, 2018[12]	China	69	43/26	15–72	N/A	N/A	66	---	11	66
Yu *et al.*, 2019[58]	China	56	30/26	29–65	N/A	N/A	55	---	---	55
Wu *et al.*, 2002[59]	China	42	28/14	12–62	N/A	N/A	41	---	----	41
Han *et al.*, 2013[60]	China	177	93/75	12–62	N/A	N/A	168	---	117	168
Fu *et al.*, 2015[61]	China	62	33/27	24–72	N/A	N/A	60	---	11	58
Wang *et al.*, 2013[62]	China	29	NA	NA	N/A	N/A	28	---	18	---
Fu *et al.*, 2015[63]	China	66	34/32	21–79	N/A	N/A	66	---	18	50
Kucukay *et al.*, 2016[64]	Turkey	32	18/14	20–42	N/A	N/A	30	---	---	30
Boyvat *et al.*, 2008[65]	Turkey	11	5/6	6–43	Bare metal stent	Wallstent, Boston Scientific	---	11	---	---
Griffith *et al.*, 1996[66]	UK	18	8/10	16–65	N/A	N/A	18	---	6	18
Yang *et al.*, 1996[67]	China	42	28/14	16–56	N/A	N/A	38	---	---	38
Gao *et al.*, 2011[68]	China	197	89/108	16–62	N/A	N/A	197	---	---	197

TIPS: Transjugular intrahepatic portosystemic shunt, DIPS: Direct intrahepatic portosystemic shunt

TIPS; and 16% (range: 12–44%) in 14 studies using TIPS [Figure 4].

Year of publication survival rate at 1 year

We noted that the rate of survival had increased progressively in recent studies. The median survival rate at 1 year was 23.50% (range: 13–34%) in four studies published before 2000 and 41% (range: 21–49%) in seven studies published between 2000 and 2005. Similarly, the median survival rate at 1 year was 35% (range: 13–46%) in five studies published between 2006 and 2010 and 51% (range: 18–92%) in 18 studies published between 2011 and 2015. The highest median survival rate, 56% (range: 36–70%) was noted in studies published after 2015 [Figure 5].

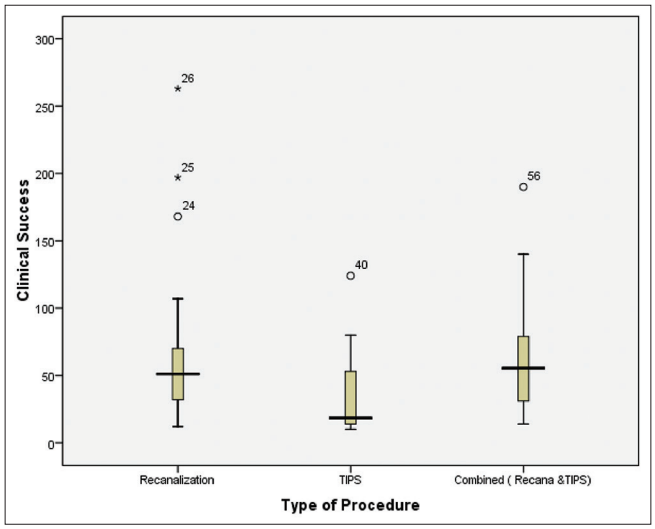


Figure 2: Box plot of median clinical success in different types of endovascular procedures (recanalization procedure in 26 studies; 51%, range: 32–70%, TIPS procedure in 14 studies; 18.50%, range: 14–53%, and combined procedures in 16 studies; 55.50%, range: 31–79%). BCS: Budd-Chiari syndrome, TIPS: Transjugular intrahepatic portosystemic shunt.

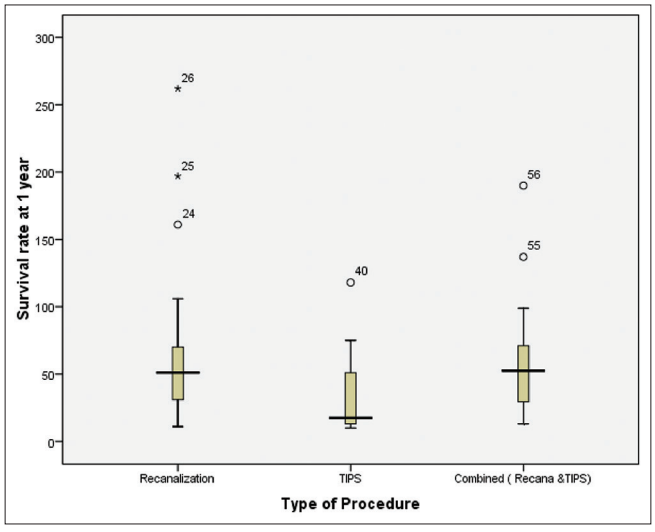


Figure 3: Box plot of median survival at 1 year different type of endovascular treatment in BCS (recanalization procedure in 26 studies; 51%, range: 31–70%, TIPS procedure in 14 studies; 17.50%, range: 13–51%, and combined procedures in 16 studies; 52.50%, range: 29–71%). BCS: Budd-Chiari syndrome, TIPS: Transjugular intrahepatic portosystemic shunt.

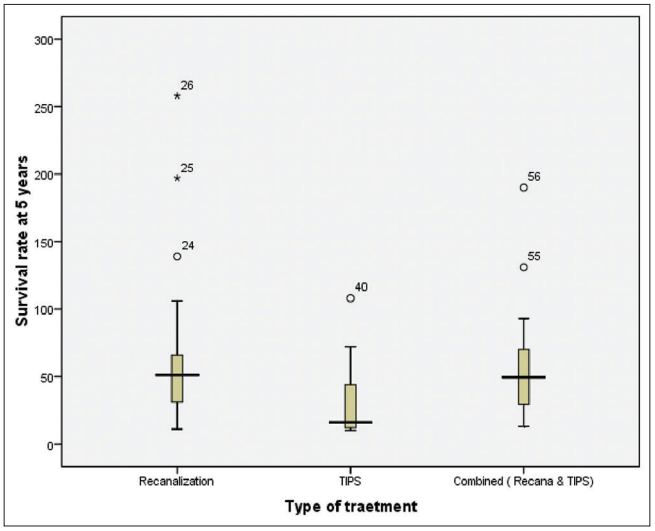


Figure 4: Box plot of median survival at 5 years different type of endovascular treatment in BCS (recanalization procedure in 26 studies; 51%, range: 31–66%, TIPS procedure in 14 studies; 16%, range: 12–44%, and combined procedures in 16 studies; 49%, range: 29–70%). BCS: Budd-Chiari syndrome, TIPS: Transjugular intrahepatic portosystemic shunt

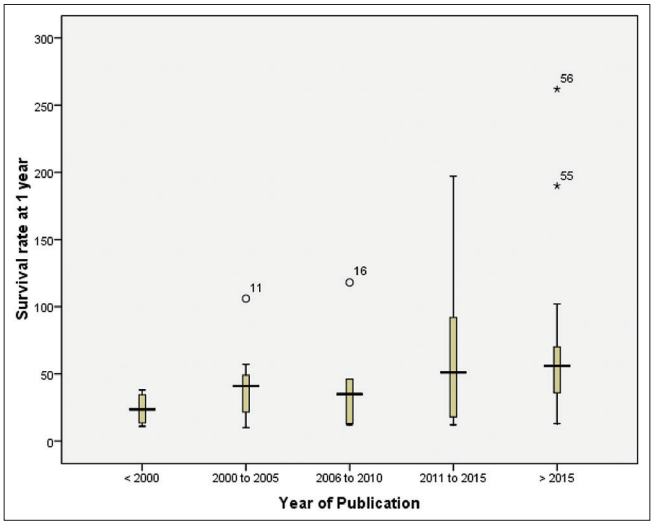


Figure 5: Box plot of median survival at 1 year according to year of publication in endovascular treatment of BCS (<2000 = 23.50%, range: 13–34%; 2000–2005 = 41%, range: 21–49%; 2006–2010 = 35%, range: 13–46%; 2011–2015 = 51%, range: 18–92%; and >2015 = 56%, range: 36–70%). BCS: Budd-Chiari syndrome.

Year of publication survival rate at 5 years

The median survival rate at 5 years was 22.50% (range: 12.5–34.5%) in four studies published before 2000, 41% (range: 21.5–47%) in seven studies published between 2000 and 2005, and 35% (range: 13–46%) in five studies published between 2006 and 2010. Similarly, the median survival rate was 48.50% (range: 18–91%) in 18 studies published between 2011 and 2015, and 55.50% (range: 34–64%) in 22 studies published after 2015 [Figure 6].

DISCUSSION

To the best of our knowledge, this is the first systematic review to present the survival rate and clinical success of different types of endovascular interventional procedures in BCS. We found that most patients with BCS were treated with recanalization rather than the TIPS procedure, our results also indicating that recanalization is more common with a better survival rate. In addition, due to the high rate of shunt dysfunction, re-intervention was more common in the TIPS procedure than in recanalization.[8,28,34,38,40] However, these findings should be interpreted cautiously, as the range of the survival rate overlapped among different methods of endovascular treatment among individual studies.

The overall clinical success rate was 93.6%, and the survival rates at 1 and 5 years were 96.9% and 93.3%, respectively, for interventional endovascular treatment of BCS in 56 studies. The median survival rates at 1 and 5 years of recanalization were 51% and 51%, respectively, which were higher than those of TIPS treatment. Recanalization is a comparatively easier and quicker procedure than TIPS, and this study indicates that recanalization is more common than TIPS. In addition, in the subgroup analysis, the survival rate based on the year of publication showed a high median survival rate published after 2015. This finding indicates that the publication survival rate has progressively increased with the development of interventional endovascular therapy in recent years.

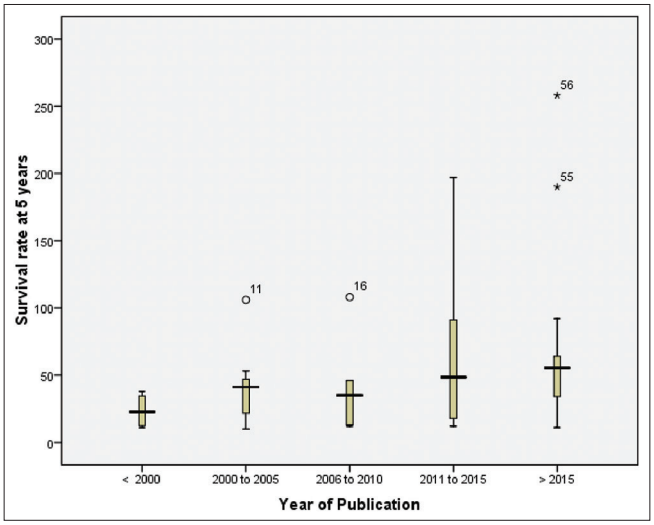


Figure 6: Box plot of median survival at 5 years according to year of publication in endovascular treatment of BCS (<2000 = 22.50%, range: 12.5–34.5%; 2000–2005 = 41%, range: 21.5–47%; 2006–2010 = 35%, range: 13–46%; 2011–2015 = 48.50%, range: 18–91%; and >2015 = 55.50%, range: 34–64%). BCS: Budd-Chiari syndrome.

In the past few decades, modern techniques and developments in interventional endovascular therapy have contributed to progressive improvements in clinical outcomes and decreased mortality in patients with BCS. Before 1985, the survival rate at 1 and 10 years was approximately 60–70%, far less than the moderate survival rate offered by modern endovascular treatment in patients with BCS, as reported in recent studies.[69,70] The treatment for BCS is best administered in an algorithm approach and depends on the response to the previous treatment.[42,71] Medical therapy alone has a low success rate in BCS; however, interventional endovascular therapy provides high patency with good outcomes.[72] In the Western countries, anticoagulation therapy and TIPS are the most commonly used treatment modalities for patients with BCS.[73] However, recanalization has shown promising results in Asian countries with excellent clinical outcomes and higher survival rates.[15]

HV recanalization was performed in patients with short-segment HV obstruction (<3 cm), and stenting was performed in long segment HV occlusion (>3 cm) with large collateral vein drainage.[37] HV recanalization is usually difficult for BCS patients with segmental obstruction, whereas TIPS placement has been widely used for BCS patients who fail to HV recanalization.[40,74]

Recanalization restoring the physiological hepatic blood flow in liver [35,40] whereas, TIPS reduce portal venous pressure resulting in decrease symptoms by physiological modification of hepatic venous flow in the patients of BCS.[75] Recanalization can minimize the risk of hepatic encephalopathy and remains a first-line treatment option in patients with BCS.[11,12] However, TIPS has less portal vein blood perfusion in the liver with patients of BCS than recanalization and a high risk of hepatic encephalopathy due to the formation of a blood ammonia level and impaired liver function after shunt placement.[46]

In BCS, one-third of short-length stenosis was treated with recanalization by PTA with or without stent placement.[13,14,55] Tripathi *et al.* followed the long-term outcome of recanalization in 63 patients with BCS[55] and compared it with previously reported 59 BCS patients treated with TIPS.[42] The survival rates for recanalization at 1, 5, and 10 years were 97%, 89%, and 85%, respectively, which

were comparable to the survival rates for TIPS. However, procedural complications and hepatic encephalopathy were significantly different (9.5% vs. 27.1%) and (0% vs. 18%), respectively.

In the past two decades, TIPS has been successfully used to treat BCS patients with a long-term survival rate.[10,76] Recently, an increasing number of patients with BCS have been managed using TIPS procedure.[77] The common indications for TIPS in patients with BCS include obstruction of all three HVs, refractory ascites, diffuse HV obstruction, portal hypertension, failed PTA, and occurrence of technical and clinical difficult to maintain long-term HV outcome patency.[78] Several previous studies have shown that TIPS can increase the survival rate in patients with BCS.[21-23,79] Qi *et al*. systematically reviewed the role of TIPS in the treatment of BCS and showed that the survival rates at 1 year and 5 years were 80–100% and 74–78%, respectively.[79] Similarly, another study examining the outcomes of interventional treatment in BCS[14] demonstrated that the survival rate of the TIPS at 1 and 5 years was 87% and 72%, and the survival rates of recanalization at 1 and 5 years were 96% and 89%, respectively. The authors also claimed that BCS patients treated with recanalization had a better survival rate than those treated using the TIPS procedure.[14] In the current systematic review, the survival rates at 1 and 5 years of recanalization were 98.5% and 95.3%, and the survival rates at 1 and 5 years for TIPS were 93.5% and 86.4%, respectively. Compared to the previous studies, our results showed a progressive increase in the survival rate.[14]

This systematic review has several limitations. First, several relevant full articles were excluded due to different analysis results and missing long-term follow-up records. Second, in the available studies, the number of patients treated using the TIPS procedure was lower than those treated with recanalization procedures. Third, the survival rate in combined (recanalization, stent, and TIPS) studies was not recorded separately. Fourth, during subgroup analysis of survival rate, a scattered distribution was observed for the year of publication. However, we noted a rapid increase in the median survival rate in studies published after 2015.

CONCLUSION

Our findings suggest that the median survival rate at 1 and 5 years of recanalization treatment is higher than that of TIPS treatment, and recanalization provides better clinical improvement. The publication year findings strongly suggest progressive improvement in intervention endovascular therapy for BCS. Thus, interventional therapy restoring the physiologic hepatic venous outflow of the liver can be considered as the treatment of choice for patients with BCS, which is a physiological modification procedure.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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