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Original Article

Bentall procedure and valve-sparing ascending aorta replacement: a comparison in treatment of aortic dissection involving the aortic root

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Abstract: Objective: To compare the effects of the Bentall procedure and valve-sparing ascending aorta replacement (VSAAR) in treating aortic dissection involving the aortic root. Methods: Between January 2015 to December 2017, 60 patients with acute Stanford type A aortic dissection involving the aortic root were assigned to receive Bentall procedure (Bentall group, n=35) or valve-sparing ascending aorta replacement (VSAAR group, n=25) according to the treatment they received. The durations of cardiopulmonary bypass and aortic cross-clamping, the rate of postoperative complications, surgical effectiveness, cardiac function parameters (left ventricular end diastolic diameter (LVDd), and left ventricular ejection fraction (LVEF)) were compared. Results: The durations of cardiopulmonary bypass (P=0.002) and aortic cross-clamping (P=0.019) in the Bentall group were significantly longer than those in the VSAAR group. The Bentall group and the VSAAR group had insignificant differences in the rates of postoperative complications (22.9% vs. 36%, P=0.265). The differences between the two groups in the rates of recovery and death were also not significant (P>0.05). Patients with VSAAR had slight but insignificantly lower LVDd and LVEF than those with Bentall procedure (P>0.05). Conclusion: VSAAR and Bentall procedures have similar effectiveness in treating aortic dissection involving the aortic root, while VSAAR is associated with shorter durations of cardiopulmonary bypass and aortic cross-clamping.

Keywords: Stanford type A aortic dissection, aortic root reconstruction, aortic valve, Bentall procedure

Introduction

Stanford type A aortic dissection is an extremely life-threatening cardiovascular disease with sudden onset and has extremely high rates of death and disability [1, 2]. The aortic sinus expands if the dissection extends to the aortic root, with or without aortic regurgitation [3-5]. Studies show that the aortic root reconstruction significantly improves prognosis [6]. Currently, controversies exist in the selection of surgical options for aortic root reconstruction [7, 8]. The Bentall procedure reconstructs the aortic root with composite aortic valve graft replacement. However, its efficacy is flawed by postoperative bioprosthetic valve failure or long-term anti-coagulant treatment, which lowers the quality of life inpatients [9]. In recent years, obvious progress has been seen in the valve-sparing aortic root reconstruction. Some studies reported that the surgical technique effectively avoids relevant postoperative complications [10]. Nevertheless, some scholars are not optimistic toward its long-term effect due to concern about the possibility of functional failure. In addition, reports on systematic research on the valve-sparing aortic root reconstruction are currently insufficient.

In order to explore a viable strategy for choosing a proper procedure for the aortic root reconstruction, this study recruited 60 patients with Stanford type A acute aortic dissection involving the aortic root and observed the differences between Bentall procedure and valve-sparing ascending aorta replacement (VSAAR).

Materials and methods

Patients

This study was approved by the Ethics Committee of the Fourth Hospital of Hebei Medical

Table 1. Comparisons on general information

Variable	Case	Age (year)	Male/Female (n, %)	Hypertension (n, %)	CD (h)	HP (n, %)	IH (n, %)
Bentall	35	42.6±7.5	23/12	24 (68.6)	9.8±1.6	19 (54.3)	4 (11.4)
VSAAR	25	45.3±6.7	16/9	18 (72.0)	8.6±1.3	14 (56.0)	3 (12.0)
t/χ^2		0.465	0.019	0.082	1.008	0.062	0.005
P		0.666	0.891	0.775	0.370	0.804	0.946

Note: VSAAR denotes valve-sparing ascending aorta replacement; CD, course of disease; HP, hydropericardium; IH, instable haemodynamics.

University and written informed consent was received from the patients. Sixty patients with Stanford type A aortic dissection were involved under the inclusion criteria as: Clinically and imageologically diagnosed Stanford type A aortic dissection; the aortic dissection involving the aortic root; expanded aortic sinus; non-involvement of coronary arterial orifices; accessible results of over one year follow-up. Patients were excluded from the study in case of: existence of rheumatic aortic valve or senile degenerative diseases; existence of surgical contraindications; unwillingness to cooperate in the study. All the patients were assigned according to the surgical procedures to undergo Bentall procedure (Bentall group, n=35) or valve-sparing ascending aorta replacement (VSAAR group, n=25).

Surgical procedures

Patients were placed in a supine position and received general anesthesia. After routine disinfection and covering the surgical site with surgical drape, a median incision was made at sternum and the skin was cut layer by layer and the sternum was split to a full exposure of the heart, ascending aorta, aortic arch, and supra-aorta arch branch vessels. After full heparinization (3 mg/kg), cardiopulmonary bypass was established by intubation in the right femoral artery, right axillary artery, and right atrium. An aortic cross clamp was placed after the anal temperature dropped to 30°C and the ascending aortic artery was incised for irrigating cardioplegic solution through left and right coronary arteries to protect the heart after the heartbeat stopped. The temperature was lowered to 18-25°C for deep hypothermic circulatory arrest. The aortic occlusion clamp was removed and cerebral protection was achieved with antegrade cerebral perfusion. Manipulation to the aortic arch, supra aortic-arch branch vessel replacement and operation on the distal end of the aortic dissection were accorded with the standard procedures [5]. The aortic root was managed with different surgical procedures in the two groups. The patients in the Bentall group had their aortic valves replaced by prosthetic valve. The aortic root was replaced by aortic prosthesis, with which the coronary ostia were reincorporated. Those in the VSAAR group underwent aortic sinus plasty, or suspension of avulsed aortic valve commissures. Intraoperative transesophageal echocardiography was performed to secure a perfect coaptation of the aortic valves.

Follow-up

All patients received one-year follow ups via out-patient appointments or phone calls. Echocardiography was re-examined at 3 months, 6 months, and 1 year. Thoracic and abdominal CTA was used for assessing the condition of the aortic root.

Outcome measures

Comparisons were made between the two groups in durations of cardiopulmonary bypass and aortic cross-clamping, postoperative complications (including secondary thoracotomy, acute renal injury, and neurological complications), and the effectiveness of the two surgical procedures. Cardiac function parameters (left ventricular end diastolic diameter (LVDd) and left ventricular ejection fraction (LVEF)) were also compared.

Statistical analysis

All data were analyzed with SPSS software, version 19.0. Measurement data are described as mean ± standard deviation. Independent-sample *t* test was used for comparison between groups. Enumeration data were described as

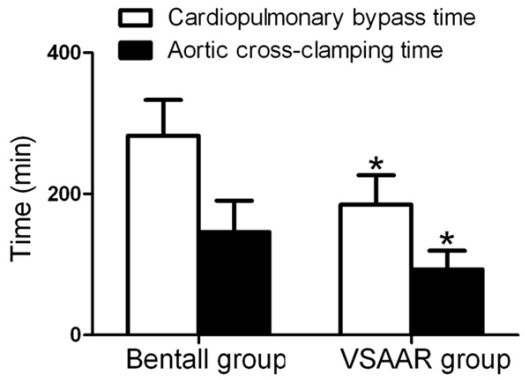

Figure 1. Comparisons of durations of cardiopulmonary bypass and aortic cross-clamping. Compared with the Bentall group, *P<0.05; VSAAR denotes valve-sparing ascending aorta replacement.

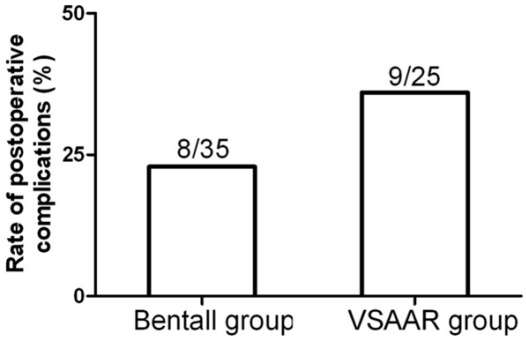

Figure 2. Comparisons of postoperative complications. VSAAR denotes valve-sparing ascending aorta replacement.

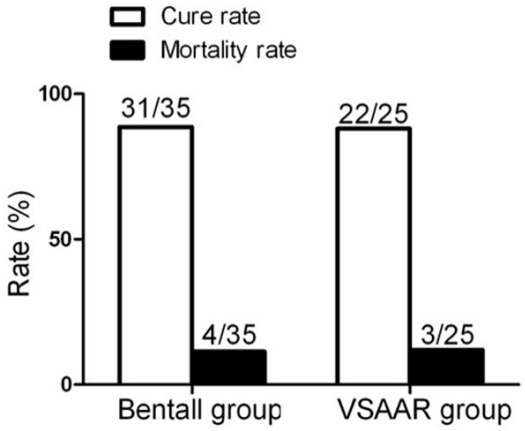

Figure 3. Comparison of the surgical effectiveness. VSAAR denotes valve-sparing ascending aorta replacement.

rates. Chi-square test was applied for comparison between groups. A *P* value less than 0.05 was deemed statistically significant.

Results

General patient information

No significant disparities were noted in comparisons of gender, age, hypertension, hydropericardium, course of disease and instable haemodynamics (all P>0.05, **Table 1**).

Comparisons of durations of cardiopulmonary bypass and aortic cross-clamping

The durations of cardiopulmonary bypass and aortic cross-clamping with Bentall procedure were respectively 282.4±45.3 min and 145.8±39.9 min, and 184.8±37.3 min and 93.1±23.7 min with VSAAR, which indicated significant differences (t=4.076, P=0.002 and t=2.782, P=0.019, respectively; **Figure 1**).

Comparisons of the rates of postoperative complications

The Bentall group had 8 cases of postoperative complications (total rate: 22.9%). The VSAAR group had 9 cases of postoperative complications (total rate: 36%). No statistical differences were observed between the two groups in the rates of postoperative complications (χ^2= 1.241, P=0.265; **Figure 2**).

Comparison of surgical effectiveness

Thirty one cases recovered from Bentall procedure, whereas 4 died. In the VSAAR group, 22 cases cured and in 3 cases the patient died. Comparisons of the rates of recovery and death between the two groups showed no significant differences (**Figure 3**).

Comparison of cardiac function

During the one-year follow-up, LVDd and LVEF at the final follow-up were respectively 48.7±6.5 mm and 64.3±7.8% with Bentall procedure, and 47.9±5.8 mm and 62.8±6.7% with VSAAR, insignificantly different between the two groups. LVDd and LVEF were also insignificantly different at 3 months and at 6 months between the two groups (**Table 2**).

Discussion

There is no need of replacing the aortic root for Stanford type A acute aortic dissection if the aortic root was not involved, which needs simple surgical procedure with good prognosis.

Table 2. Comparisons of LVDd and LVEF

Variable	LVDd			LVEF		
	3 mon	6 mon	12 mon	3 mon	6 mon	12 mon
Bentall	50.7±6.8	49.5±6.7	48.7±6.5	57.7±7.3	61.8±7.5	64.3±7.8
VSAAR	51.2±6.3	50.4±6.0	47.9±5.8	58.6±7.6	60.5±7.1	62.8±6.7
t value	0.289	0.535	0.159	0.463	0.677	0.253
P value	0.773	0.594	0.881	0.645	0.501	0.813

Note: LVDd denotes left ventricular end diastolic diameter; LVEF, left ventricular ejection fraction.

Dispute exists on the procedure of treating aortic root involved dissection. The aim of managing the dissected aortic root is to completely clear the dissection and to restore the function of the aortic wall. Appropriate operation of the aortic root ensures a successful surgical procedure [11]. Therefore, it has been a hotspot of research on the choice of correct surgical procedures for root involved aortic dissection and improvement of the surgical effectiveness [12, 13].

As a classical surgical procedure for dissection involving aortic root, Bentall procedure replaces the aortic root, removes the dissection and eradicates the possibility of recurrence [14, 15]. Studies proved the safety, effectiveness and good long-term prognosis of Bentall procedure for treatment of expansion of aortic sinus and aortic insufficiency due to the root involved aortic dissection. However, in this study, removal of the aortic valves without severe pathological changes by Bentall procedure might seriously lower the quality of life and increase the psychological burden of young patients as they have long life expectancy. It might also lead to complications including embolism and hemorrhage due to long term anticoagulant treatment after the surgery. Therefore, VSAAR was conducted in this study, due to the fact that it needs no anti-coagulant treatment, which avoids anti-coagulation related complications. But the differences in effectiveness between the two procedures need further studies.

The VSAAR procedure in this study had remarkably shorter durations of cardiopulmonary bypass and aortic cross-clamping than the Bentall procedure, indicating a lower incidence of complications of VSAAR and relative simplicity of intraoperative cardiac protection. According to previous studies, deaths after surgical repair of aortic dissection are mainly caused by multiple organ failure, repeated pulmonary infection, repeated gastrointestinal bleeding and large area cerebral infarction [16, 17]. Multiple organ failure, pulmonary infection and gastrointestinal bleeding may be related to surgical wound, long bedrest period, long recovery time, existence of underlying diseases, or long cardiopulmonary bypass [18]. The results of this study demonstrated no statistical difference between Bentall and VSAAR procedures in the rates of recovery and death, which suggests that the two procedures have similar therapeutic effects in treating root involved aortic dissection. Comparisons of secondary thoracotomy, acute renal injury, neurological complications and hemorrhage showed no statistically significant differences in the rates of post-surgical complications between the two procedures. This result was consistent with those of the studies conducted by Stephens et al. and Beckmann et al. [19, 20]. The one-year follow-up on LVDd and LVEF revealed no statistical differences between the two groups, confirming a substantial short-term effect of VSAAR as compared with Bentall procedure.

In summary, VSAAR is worthy of clinical general use for its advantages including the equivalent short-term effectiveness to Bentall procedure and shorter durations of cardiopulmonary bypass and aortic cross-clamping. This study is limited in its small sample size, monocentric study, short-term retrospective study and short-term follow-up. Further evidence is needed via enlarging the sample size, conducting multi-center studies, and performing long-term follow-ups.

Disclosure of conflict of interest

None.

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References

[1] Evangelista A, Isselbacher EM, Bossone E, Gleason TG, Eusanio MD, Sechtem U, Ehrlich MP, Trimarchi S, Braverman AC, Myrmel T, Harris KM, Hutchinson S, O'Gara P, Suzuki T, Nienaber CA and Eagle KA. Insights from the international registry of acute aortic dissection: a 20-year experience of collaborative clinical research. Circulation 2018; 137: 1846-1860.

[2] Kotha VK, Pozeg ZI, Herget EJ, Moon MC and Appoo JJ. Early results of the PETTICOAT technique for the management of acute type A aortic dissection. Aorta (Stamford) 2017; 5: 124-128.

[3] Yang B, Malik A, Waidley V, Kleeman KC, Wu X, Norton EL, Williams DM, Khaja MS and Hornsby WE. Short-term outcomes of a simple and effective approach to aortic root and arch repair in acute type A aortic dissection. J Thorac Cardiovasc Surg 2018; 155: 1360-1370, e1361.

[4] Tanaka H, Ikeno Y, Abe N, Takahashi H, Inoue T and Okita Y. Outcomes of valve-sparing root replacement in acute type A aortic dissection. Eur J Cardiothorac Surg 2018; 53: 1021-1026.

[5] Contreras V, Sheinbaum R, Tran S, Zaki J and Moise O. Aortic regurgitation in acute type A dissection. J Cardiothorac Vasc Anesth 2018; 32: e50-e51.

[6] Kallenbach K, Oelze T, Salcher R, Hagl C, Karck M, Leyh RG and Haverich A. Evolving strategies for treatment of acute aortic dissection type A. Circulation 2004; 110: Ii243-249.

[7] Yang B, Patel HJ, Sorek C, Hornsby WE, Wu X, Ward S, Thomas M, Driscoll A, Waidley VA, Norton EL, Likosky DS and Deeb GM. Sixteen-year experience of david and bentall procedures in acute type A aortic dissection. Ann Thorac Surg 2018; 105: 779-784.

[8] Rahnavardi M, Yan TD, Bannon PG and Wilson MK. Aortic valve-sparing operations in aortic root aneurysms: remodeling or reimplantation? Interact Cardiovasc Thorac Surg 2011; 13: 189-197.

[9] Hsu PS, Chen JL, Tsai CS, Tsai YT, Lin CY, Lee CY, Ke HY and Lin YC. Subclavian artery cannulation provides better myocardial protection in conventional repair of acute type A aortic dissection: experience from a single medical centre in Taiwan. Cardiovasc J Afr 2016; 27: 143-146.

[10] Lee H, Cho YH, Sung K, Kim WS, Park KH, Park PW and Lee YT. Clinical outcomes of valve-sparing root replacement in acute type A aortic dissection. Scand Cardiovasc J 2015; 49: 331-336.

[11] Chiu P and Miller DC. Evolution of surgical therapy for stanford acute type A aortic dissection. Ann Cardiothorac Surg 2016; 5: 275-295.

[12] Tian D, Rahnavardi M and Yan TD. Aortic valve sparing operations in aortic root aneurysms: remodeling or reimplantation? Ann Cardiothorac Surg 2013; 2: 44-52.

[13] Fazel SS and David TE. Aortic valve-sparing operations for aortic root and ascending aortic aneurysms. Curr Opin Cardiol 2007; 22: 497-503.

[14] Zizza A, Pano M, Zaccaria S, Villani M and Guido M. Outcome of acute type A aortic dissection: single-center experience from 1998 to 2007. J Prev Med Hyg 2009; 50: 152-158.

[15] Tanaka M, Kimura N, Yamaguchi A and Adachi H. In-hospital and long-term results of surgery for acute type A aortic dissection: 243 consecutive patients. Ann Thorac Cardiovasc Surg 2012; 18: 18-23.

[16] Kreibich M, Rylski B, Bavaria JE, Branchetti E, Dohle D, Moeller P, Vallabhajosyula P, Szeto WY and Desai ND. Outcome after surgery for aortic dissection type A in morbidly obese patients. Ann Thorac Surg 2018; 106: 491-497.

[17] Subramaniam K and Sheppard MN. Thoracic aortic dissection. Death may not always be due to rupture with haemorrhage. Unusual complications which can be missed at autopsy. J Forensic Leg Med 2018; 54: 127-129.

[18] Bossone E, LaBounty TM and Eagle KA. Acute aortic syndromes: diagnosis and management, an update. Eur Heart J 2018; 39: 739-749d.

[19] Stephens EH and Borger MA. Getting to the root of the matter: management of the aortic root in type A aortic dissection. Eur J Cardiothorac Surg 2016; 50: 230-231.

[20] Beckmann E, Martens A, Alhadi FA, Ius F, Koigeldiyev N, Fleissner F, Stiefel P, Kaufeld T, Haverich A and Shrestha M. Is bentall procedure still the gold standard for acute aortic dissection with aortic root involvement? Thorac Cardiovasc Surg 2016; 64: 116-123.