Original Article

A Simple Modification in the Bentall Operation for Better Results (Added Protection Layer)

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ABSTRACT

Background: Bleeding and pseudoaneurysm formation are the dangerous complications of the Bentall operation. We made a simple modification to the proximal anastomosis in the Bentall operation to reduce postoperative bleeding and false aneurysm incidence. This article presents a review of the early results.

Methods: Totally, 171 consecutive patients (126 men and 45 women) underwent aortic root replacement between September 2014 and April 2020: as an elective operation in 130 patients (76.02%) and as an emergent or urgent operation in 41 (23.98%). No exclusion criteria were applied. All the Bentall operations during the study period were performed via the same surgical technique. Statistical analysis was conducted with the SPSS 11.0 statistical software package (SPSS, Chicago, IL, USA). Continuous variables were expressed as the mean ± the standard deviation and compared using the unpaired 2-tailed *t* test, and categorical variables were analyzed using the χ^2 test or the Fisher exact test, where appropriate.

Results: The mean duration of cardiopulmonary bypass was 88.30 minutes, and the mean duration of aortic clamping was 53.17 minutes. Reoperation was required due to postoperative bleeding in 14 cases (8.19%). The early mortality rate was 8.77%, and the incidence of complications was 15.19%.

Conclusions: Our simple modification, which was the addition of a protection layer, to the standard technique of the Bentall operation did not significantly increase the duration of cardiopulmonary bypass, and it seemed to have caused a significant decrease in bleeding after surgery and the need for reoperation. ***(Iranian Heart Journal 2022; 23(3): 42-48)***

KEYWORDS: Bentall operation, Aortic root reconstruction, Cardiac surgery

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Received: December 31, 2020 **Accepted:** October 12, 2021

The Bentall operation is one of the major and complex cardiac surgeries. Since the introduction of the Bentall surgery by Bentall and De Bono in 1988, this technique has been introduced as the main and standard operation in patients who need aortic valve and aortic root replacement.[1-3]

Major complications related to this operation are bleeding from anastomosis sites and complications of the coronary anastomosis to the graft including stretching on the coronary ostia, the kinking of the coronary arteries, and false aneurysm formation.[2]

In recent years, various modifications have been made to improve the results of this operation.[2-4]

We made a simple modification to a portion of the Bentall surgery to reduce the amount of postoperative bleeding and the incidence of false aneurysm formation. In this article, the early results of this change in patients undergoing this operation will be reviewed.

METHODS

In this descriptive, cross-sectional research, the records of all patients (171 patients) undergoing aortic valve and aortic root replacement between September 2014 and April 2020 at Imam Khomeini Hospital, affiliated with Tehran University of Medical Sciences, were studied.

During this period, 171 consecutive patients (126 men and 45 women) underwent aortic root replacement. The procedure was performed as a selective operation in 130 patients (76.02%) and as an emergent or urgent operation in 41 (23.98%).

The main indications for surgery included annuloaortic ectasia with pathologic findings consistent with cystic medial necrosis and aortic valve insufficiency in 111 patients, aortic dissection with severe aortic insufficiency in 20, and aortic valve endocarditis in 41.

The aortic valve was congenitally bicuspid in 37 patients (21.64%). A total of 39 patients (22.81%) had previously undergone cardiac surgery.

The demographic data, preoperative risk factors, and operative details of the 171 patients analyzed are summarized in Tables 1 and 2.

Table 1: Baseline characteristics

Characteristics	n (%)
Demographic Data	
Age (y) ± SD	48.28 ± 16.76
Male/Female	126/45 (73.68/26.32)
Comorbidities	
Hypertension	38 (22.22)
Diabetes mellitus	9 (5.30)
CAOD	18 (10.53)
CVA	7 (4.09)
Chronic renal failure	10 (5.85)
Cardiac Operations	
Previous cardiac operation	39 (22.81)
Emergency operation	41 (23.98)
Aortic Pathologies	
Annuloaortic ectasia	111 (64.91)
Acute dissection	20 (11.70)
Marfan syndrome	3 (1.75)
Bicuspid aortic valve	37 (21.64)
Endocarditis	41 (23.98)
Ejection Fraction	
≥50%	87 (50.88)
40-50%	38 (22.22)
30-40%	29 (16.96)
≤30%	17 (9.94)

COPD, Coronary artery occlusive disease; CVA, Cerebrovascular accident

Table 2: Operative data

Variables	n (%) or mean ± SD
CPB time (min)	162.24 ± 56.40
ACC time (min)	116.12 ± 34.66
HCA	31 (18.13)
HCA time (min)	14.00 ± 7.11
Valve Type	
Mechanical	99 (57.89)
Biological	6 (3.51)
Other Surgical Types	
Valve-sparing	9 (5.26)
Homograft	58 (33.92)
Concomitant Procedures	
Ascending aorta replacement	4 (2.34)

Hemiarch replacement	1 (0.58)
Total arch replacement	1 (0.58)
CABG	20 (11.70)
Mitral valve repair	17 (9.94)
Mitral valve replacement	10 (5.85)
Tricuspid valve repair	9 (5.26)
VSD patch repair	5 (2.92)
Others	

CBP, Cardiopulmonary bypass; ACC, Aortic cross-clamp; HCA, Hypothermic circulatory arrest; CABG, Coronary artery bypass graft; VSD, Ventricular septal defect

All these operations were performed by the same surgeon.

There were no exclusion criteria. Additionally, all the Bentall operations during the study period were performed via the same surgical technique, precluding the formation of a control group.

The study population underwent general anesthesia, middle sternotomy, full-dose heparinization, and arterial and venous cannulation before the commencement of the cardiac bypass cycle. Thereafter, the ascending aorta was completely cut from about 2 cm below the cross-clamp site, with the long cut continued toward the proximal portion. The aortic valve leaflets were then removed, and the coronary ostia were separated and released through the lateral margins. Subsequently, sutures were placed in proper positions with firm hooks and tied.

Next, the second layer of the proximal anastomosis was performed continuously with the same extension of the previous Prolene suture by taking the upper edge (far edge) of this free piece to the remaining aortic tissue at the top of the annulus in each stitch. Notably, in patients with no suitable aortic wall residue above the aortic annulus for any reason, we used a pericardial patch with an approximate width of 2 cm and an appropriate length instead of the aortic wall in any part of the suture line. The proximal anastomosis was carried out continuously by taking the lower edge of the free piece and sewing the ring and the near edge of the pericardium at each turn. Afterward, the second layer of the anastomosis was continuously performed by the same extension of the previous Prolene suture by taking the far edge of this free piece to the farther edge of the pericardium instead of the aortic tissue above the annulus. In the next stage, the left coronary artery was anastomosed to the graft, the distal part of the graft was anastomosed to the ascending aorta, and the right coronary artery was anastomosed to the graft as the standard method.

Then, in our modified method, the proximal anastomosis is carried out. A piece of the upper part of the tubular graft with an approximate length of 2 cm is cut (free piece) and drawn to the proximal part of the graft before it is placed in the vicinity of the sewing ring. Next, the proximal anastomosis with Prolene 3/0 (needle 17) sutures is done continuously by grabbing the lower edge of the free piece and sewing the ring of the prosthetic valve, followed by the aortic annulus, at each turn. Importantly, the needle should not be inserted into the main graft under any circumstances.

All complications and problems in the operating room and the intensive care unit (ICU), as well as the amount of postoperative drainage in all the cases, were checked and registered.

Statistical Analysis

The statistical analyses were conducted with the SPSS 11.0 statistical software package (SPSS, Chicago, IL, USA). Continuous variables were expressed as the mean ± the standard deviation and compared using the unpaired 2-tailed *t* test. Categorical variables were analyzed with the χ^2 test or the Fisher exact test, where appropriate.

RESULTS

Totally, 171 patients, consisting of 126 men and 45 women underwent aortic valve

replacement. Concerning the surgical schedule, the operations were performed as elective operations in 130 patients (76.02%) and emergent or urgent operations in 41 (23.98%). The mean age of the patients was 48.28 years, with a minimum age of 14 and a maximum age of 78 years.

The mean duration of cardiopulmonary bypass was 88.30 minutes, and the mean duration of aortic clamping was 53.17 minutes.

Hypothermic circulatory arrest was drawn upon in 31 patients (18.13%), at an average time of 14 minutes.

In 9 patients, the aortic valve was repaired before aortic root replacement. Aortic homografts were used in 58 cases (33.92%).

The most frequent surgical operations performed, in addition to the main operation, were coronary artery bypass grafting and mitral valve surgery, respectively.

Reoperation was required due to postoperative bleeding or transfer to the ICU with an open sternum, requiring another repair in a second operation, in 14 cases (8.19%). The early mortality rate was 8.77%, and the incidence of complications was 15.19%.

The mortality rate, the incidence of complications, and causes are presented in Table 3.

Table 3: Postoperative Data

Variables	n (%) or mean ± SD
Reexploration for bleeding	14 (8.19)
Hospital mortality	15 (8.77)
Causes of Early Mortality	
Low cardiac output syndrome	5 (2.92)
Hemorrhage	1 (0.58)
Multiorgan failure	2 (1.17)
Myocardial infarction	1 (0.58)
Cardiac arrhythmias	2 (1.17)
GI complications	1 (0.58)
Complications	
Renal failure	4 (2.34)
Perioperative myocardial infarction	5 (2.92)
Postoperative arrhythmia (V-fib,V-tach, AV block)	1 (0.58)
Neurologic complications	6 (3.51)
Pulmonary complications	7 (4.09)
Infectious complications	3 (1.75)

CBP, Cardiopulmonary bypass; ACC, Aortic cross-clamp; HCA, Hypothermic circulatory arrest; CABG, Coronary artery bypass graft, VSD, Ventricular septal defect; GI, Gastrointestinal

DISCUSSION

The Bentall operation is one of the major and complex cardiac surgeries.

In a meta-analysis study, Mookhoek et al[1] examined post-surgery outcomes in 46 studies on 7629 patients and reported a premature mortality rate of 6% and a late mortality rate of 2.02%. However, patients with aortic dissection, reoperation, or biological valves were not included in their study.

In the Society of Thoracic Surgeons database, the early mortality rate in adult patients undergoing root reconstruction with a valved conduit (including patients with acute endocarditis and those operated on non-electively) between 2000 and 2011 was 8.9%. The rate of early mortality in the statistics of the Association of Thoracic Surgeons between 2000 and 2011 was about 8.9%. In addition, the incidence of valve complications in patients was about 26.6% during 10 years, including important bleeding and thromboembolism.[1]

The rate of aortic root reoperation has declined in recent years, while the rates of late mortality, important bleeding, and thromboembolism are still of concern. Other complications were low cardiac output (9.9%), the dissection or rupture of the distal aorta (8.9%), bleeding (4.1%), stroke (3.8%), endocarditis (3.7%), arrhythmia (3.3%), and other cardiac deaths (9.6%).[1]

In the last 2 decades, most centers have consistently reported an operative mortality rate for acute type A dissection of between 10% and 30%.[5]

Recent years have witnessed the introduction of various modifications aimed

at improving the results of the Bentall operation.[4,5] Such changes to the primary operation have been made by different surgeons to reduce the stretching to the coronary ostia, the kinking of the coronary arteries, bleeding, and the duration of the operation.[4,5]

For the control of bleeding and the reduction of the stretching of the site of coronary anastomosis, Nezic et al[7] used the collar technique. In the same direction, they utilized a double-layered sewing ring for the annulus anastomosis before performing coronary ostia anastomosis as a modified endo-button technique introduced by Stefano Pratali et al.[8] The Carrel patch and the inclusion technique by Hashimoto et al[9] via the anastomosis of the aortic wall around the ostia of the coronary arteries with tubular grafts and without the release of the coronary ostia was introduced by Nezafati et al.[10]

For the control of bleeding from the site of the proximal anastomosis, Hussian et al[2] used the cuff technique. Following the anastomosis of the sewing ring to the annulus, the remaining aortic wall in the Valsalva sinuses (height=8–9 mm) was sewn continuously to the graft as a second layer. The formation of the cuff of the remnant of the aorta during the proximal anastomosis resulted in a significant reduction in postoperative bleeding and improved hospital outcomes.[16]

In a modified technique by Copeland et al,[11] first, the lower part of the sewing ring was sewn individually to the aortic annulus with 3/0 Dacron sutures, and then the upper part of the sewing ring was continuously sewn into the cut edge of the aortic wall at the top of the annulus with 3/0 monofilament sutures. They concluded that the technique markedly improved hemostasis.

Mohite et al[12] used the pericardial strip to reinforce the proximal anastomosis in 10 cases. The strip could also be sutured to the left ventricular outflow tract in the case of bleeding from the proximal anastomosis in that particular region.

The proximal anastomosis is performed as separate and imbricate sutures, and Fibrin glue was used at the site of the proximal anastomosis by Della Corte.[13]

Additionally, the flanged technique was drawn upon by Yakut et al,[14] the miniskirt technique by Guido Michielon,[15] and the modified wrapping-internal shunt method by Mingjia Ma.[17]

Chen and Dai[18] employed the modified method to perform the proximal anastomosis. In this method, a piece of the upper part of the tubular graft with an approximate length of 1 to 1.5 cm was cut and brought down from around the graft to the distal part of the graft, adjacent to the sewing ring. It was then sewed to the sewing ring continuously with Prolene 4/0 sutures. Next, the proximal anastomosis with pledget sutures 2/0 was performed individually and then with Prolene 4/0 suture continuously. The extra piece of Dacron was sewn into the remaining aorta at the top of the annulus. The method reduced the amount of postoperative drainage by about 51% compared with the control group. The difference between our method and their method is that in our method, both layers are continuously sewn; in addition, the free piece is not sewn separately into the sewing ring.

Some points should be noted about patients in the present study. Cases of endocarditis due to the presence of an active infectious disease department in this center and referral from other centers constitute a significant percentage of patients. Furthermore, the presence of a transplanted organ bank and a large number of patients with endocarditis in this center made the use of aortic homograft significant.

There were no exclusion criteria in the current study; therefore, all patients,

including dissection and reoperation for the second or more times were also present in the study. Still, the rates of complications and death were acceptable. The mortality rate in our patients was about 8.77%, and the incidence of complications was about 15.19%.

Limitations

All the Bentall operations on the study population were performed with the same surgical technique, precluding the formation of a control group.

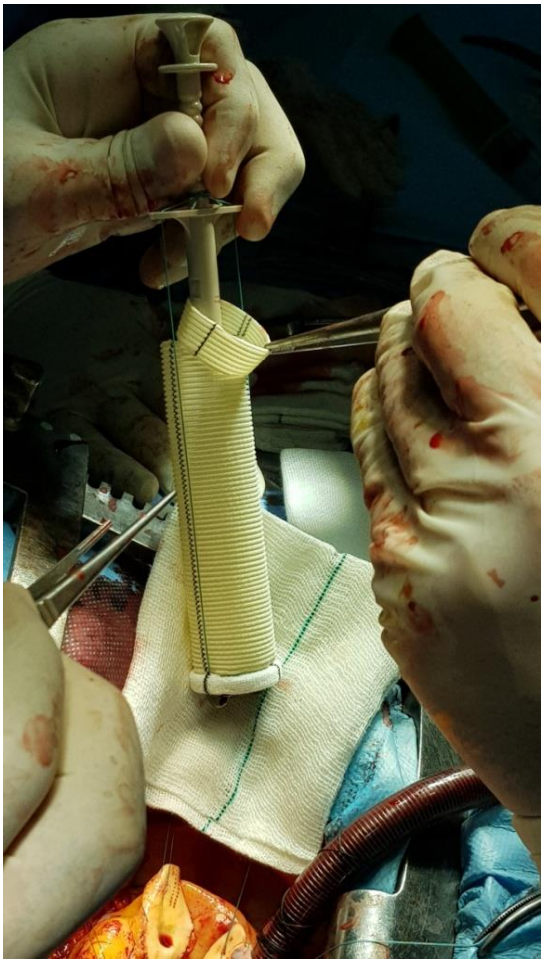

Figure 1: Composite graft

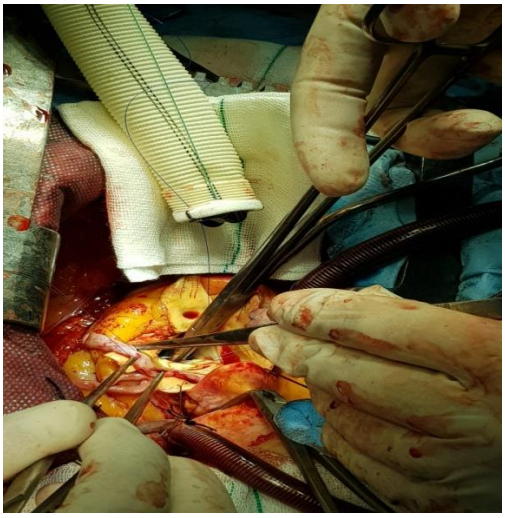

Figure 2: Technique of reinforcement

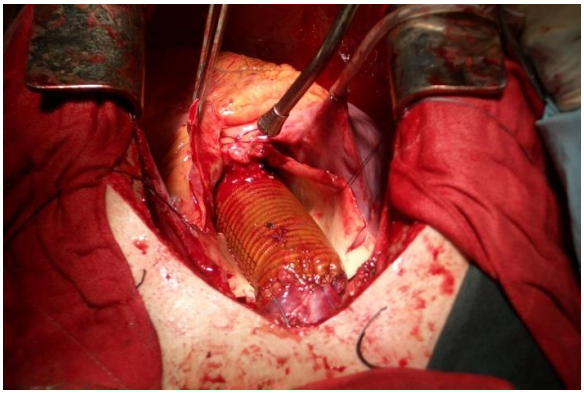

Figure 3: Bentall operation

CONCLUSIONS

Our simple modification, the addition of a protection layer, to the standard technique of the Bentall operation did not significantly increase the duration of cardiopulmonary bypass, and it seemed to have caused a significant decrease in the amount of bleeding after surgery and the need for reoperation. Using this method more broadly in multicenter studies will help determine its long-term efficacy.

Acknowledgments

We hereby thank all the personnel of the Imam Khomeini Cardiovascular surgery Department.

Conflict of Interest: The authors hereby declare that there were no conflicts of interest.

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