

Minimally Invasive Surgery with the Bentall-De Bono Technique. Initial Experience at Hospital Italiano de Buenos Aires

Cirugía de Bentall de Bono por abordaje miniinvasivo. Experiencia inicial del Hospital Italiano de Buenos Aires

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ABSTRACT

Background: Cardiac surgery avoiding full sternotomy began to emerge in the 1990s with the first hemi-sternotomies and mini-thoracotomies. Aortic valve and root surgery is one of the most common procedures in our field. In this paper, we analyze our experience in minimally invasive cardiac surgery (MICS) for the aortic root with the Bentall-De Bono technique (MICS-Bentall).

Objective: To analyze the surgical results in the first 10 patients underwent a MICS-Bentall procedure at our site.

Methods: A retrospective observational study was carried out including patients with valve disease and aortic root dilation who underwent a surgery with the MICS-Bentall procedure in a tertiary care hospital from December 2019 to December 2020. Continuous variables were expressed as mean and standard deviation or median and interquartile range according to the observed distribution. Categorical variables were expressed as absolute and relative frequency.

Results: Out of 165 patients undergoing aortic root surgery, 10 patients were included. Mean age was 56 ± 17.03 years, 70% male; all cases were elective. Median (interquartile range, IQR) STS PROM % was 1.48 (1- 2.02). Eighty percent had bicuspid valve. Fifty percent of patients were extubated within 6 hours. In the 30-day follow-up, no death was recorded, and two complications were registered: one patient experienced atrial fibrillation without hemodynamic decompensation and another a wound infection. The mean hospital length of stay was 5 days.

Conclusion: In our experience, MICS using the Bentall technique showed satisfactory results in terms of low perioperative mortality, early extubation, and short hospital stay.

Keywords: Cardiac Surgical Procedures - Minimally Invasive Surgical Procedures - Aortic Valve Disease - Bicuspid Aortic Valve Disease - Aorta

RESUMEN

Introducción: La cirugía cardíaca libre de esternotomía completa surge en los años 90 con las primeras esternotomías y toracotomías mínimas. La cirugía de la válvula y la raíz aórtica constituyen uno de los procedimientos más frecuentes en nuestro campo. En este trabajo analizamos nuestra experiencia en Cirugía Cardíaca Miniinvasiva (MICS) de la raíz aórtica con la técnica Bentall de Bono (MICS-Bentall).

Objetivo: Analizar los resultados quirúrgicos en los primeros 10 pacientes intervenidos con MICS-Bentall en nuestra institución.

Material y métodos: Se realizó un estudio observacional retrospectivo en el que se incluyeron los casos de valvulopatía y dilatación de la raíz aórtica intervenidos quirúrgicamente mediante MICS-Bentall en un hospital de alta complejidad durante el periodo diciembre 2019 - diciembre 2020. Las variables continuas se expresan como media y desvío estándar o mediana y rango intercuartílico según la distribución observada. Las variables categóricas como frecuencia absoluta y relativa.

Resultados: Sobre 165 pacientes sometidos a cirugía de la raíz aórtica, se incluyeron 10 pacientes. La edad media fue de $56 \pm 17,6$ años, 70% de sexo masculino, todos fueron electivos. La mediana (rango intercuartílico, RIC) de STS PROM % fue de 1,48 (1-2,02). En el 80% la válvula aórtica era bicúspide. El 50% de los pacientes fue extubado dentro de las 6 horas. En seguimiento a 30 días no se registraron óbitos, y hubo 2 complicaciones: un paciente presentó fibrilación auricular sin descompensación hemodinámica, y otro infección de herida. La estadía hospitalaria fue en promedio de 5 días.

Conclusión: En nuestra experiencia con MICS con la técnica Bentall se obtuvieron resultados satisfactorios con baja mortalidad perioperatoria, extubación precoz y tiempos cortos de estancia hospitalaria.

Palabras Claves: Procedimientos quirúrgicos cardíacos - Procedimientos quirúrgicos mínimamente invasivos - Enfermedad de la válvula aórtica - Enfermedad de la válvula aórtica bicúspide - Aorta

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INTRODUCTION

Cardiac surgery avoiding full sternotomy began to emerge in the 1990s with the first hemi-sternotomies and mini-thoracotomies. (1-3) Over the years, these techniques became increasingly popular and are now routine procedures at tertiary care facilities. Minimally invasive procedure has also been developed in valve and aortic surgery. (4) Despite the experience confirmed by large facilities all over the world, we currently lack randomized controlled trials. The first experiences with minimally invasive aortic valve and root surgery have shown that at least we can achieve the same results as with conventional cardiac surgery. (5) In this paper, we analyze our experience in minimally invasive cardiac surgery (MICS) for the aortic root with the Bentall-De Bono technique (MICS-Bentall).

METHODS

A retrospective observational study was performed with 165 patients who underwent surgery using Bentall-De Bono procedure from December 2019 to December 2020 by searching our electronic medical records.

Out of 165 patients, 155 were excluded, since they had undergone combined procedures (double valve replacement and myocardial revascularization surgery), or they had endocarditis, “porcelain aorta” (calcification throughout the whole perimeter of the aorta), previous chest radiation, severe mitral ring calcification, or full sternotomy.

Ten patients who underwent minimally invasive surgery were evaluated.

The primary objective was to analyze 30-day mortality, and the secondary objective was to analyze technical and surgical outcomes with the following variables: postoperative bleeding and need for transfusion/coagulation factors, hospital length of stay, stroke, extracorporeal circulation (ECC)/aortic cross-clamping (ACC) times.

Surgical Technique

General anesthetic and intra-operative echocardiography were used in all patients. A 4-cm incision was performed from 2 to 3 cm under the angle of Louis. Preserving xiphoid, pre-sternal muscle flaps were created for ease of rib cage expansion when using the saw. The type of cannulation was decided on a case-by-case basis. However, aortic arch cannulation was chosen with reference to the arterial line (EOPA- Edwards™), and venous cannulation was peripherally performed using a guiding cord by means of the Seldinger technique towards the right atrium under long-cannula echocardiographic monitoring (Edwards™ or Medtronic™). Following aortic cross-clamping, antegrade and/or retrograde myocardial protection was performed via coronary sinus cannulation, and the type of cardioplegia was at the surgeon's discretion. Resection of the native aortic valve and root treatment were performed using conventional techniques. (6-8)

Statistical analysis

Consecutive sampling was used; therefore, all patients meeting eligibility criteria were enrolled. Continuous variables are expressed as mean and standard deviation, or median and interquartile (IQR) range according to the observed distribution. Categorical variables are expressed as absolute and relative frequency.

Ethical considerations

The study was conducted following recommendations for research in human beings and any applicable regulations. As medical records were reviewed and no holder identification data were reported, the patients did not provide their informed consents (except for missing data, collected via phone calls). The study members took actions to protect the privacy and confidentiality of data according to applicable regulations (Act 25 326 on Personal Data Protection).

RESULTS

Ten patients were included and underwent MICS.

Preoperative characteristics

Preoperative variables are described in Table 1. All patients had elective surgeries. Most were male (n = 7), and the mean age was 56 years. The most relevant comorbidities were hypertension and dyslipidemia; 2 patients were ex-smokers, and one had chronic renal failure.

Eight patients had bicuspid valve diagnosis, 9 had preserved ventricular function (left ventricular ejection fraction >55%), no patient had previous cardiac surgery, 5 patients had severe aortic valve stenosis, and 5 patients had moderate to severe aortic regurgitation. Nine patients had dilated ascending aorta >45 mm, and one patient had severe aortic stenosis, bicuspid valve, and 40 mm aneurysm. All sample patients had a mild average preoperative risk based on the STS score, except one with moderate risk (average STS 5).

Intraoperative characteristics (Table 2)

Half the patients received a biological and the other half received a mechanical valve prosthesis. The most commonly used valve size was 23 mm.

Mean extracorporeal circulation (ECC) and aortic cross-clamping (ACC) times were 168 minutes and 126 minutes, respectively. One patient required red blood cell transfusion, 5 patients required platelet transfusion, and 2 patients received fibrinogen. No patient underwent reoperation from bleeding, suffered from postoperative renal failure, had neurological events, or needed a permanent pacemaker.

Postoperative results (Table 3)

Only one patient required extubation beyond 24 hours and died 33 days after surgery due to urinary sepsis. One patient was reoperated 20 days after the procedure as a result of turbid secretion from the sternal wound; surgical toilet was performed.

On average, total length of stay was 5 days, except for one patient with prolonged hospitalization until day 10 due to heart failure.

No reoperation was performed, no cerebrovascular accident was observed, no permanent pacemaker was needed, and no perioperative death occurred.

DISCUSSION

The MICS technique is one of the less painful postoperative procedures, with the least amount of bleeding,

Table 1. Preoperative characteristics

| | |
|---|---|
| Age, years, mean \pm SD | 56.09 \pm 17.60 |
| Male sex, n | 7 |
| HTN, n | 5 |
| COPD, n | 0 |
| Dyslipidemia, n | 5 |
| DM, n | 0 |
| CRF, n | 1 |
| Dialysis | 0 |
| Preoperative stroke, n | 0 |
| NYHA functional class, n | I: 5 II: 3 III: 2 IV: 0 |
| Coronary surgery, n | 0 |
| AF, n | 0 |
| Obesity, n | 2 |
| Coagulation disorder, n | 0 |
| Peripheral artery disease, n | 0 |
| Ex-smoker, n | 2 |
| Bicuspid valve, n | 8 |
| Valve disease, n | Moderate to severe stenosis: 5 Moderate to severe regurgitation: 5 |
| Aortic valve area (cm ²), mean \pm SD | 1.64 \pm 1.23 |
| Aortic ring diameter (cm), mean \pm SD | 2.41 \pm 0.28 |
| Aortic root diameter (cm), mean \pm SD | 4.11 \pm 0.83 |
| Ascending aorta diameter (cm), mean \pm SD | 4.66 \pm 0.44 |
| Pulmonary arterial pressure (mmHg), mean \pm SD | 25.6 \pm 3.77 |
| Hematocrit (%), mean \pm SD | 39.9 \pm 2.60 |
| STS average (%), median (IQR) | 1.48 (1- 2.02) |

AF: atrial fibrillation; COPD: chronic obstructive pulmonary disease; CRF: chronic renal failure; DM: diabetes mellitus; HTN: hypertension; IQR: interquartile range; NYHA: New York Heart Association heart failure scoring; SD: standard deviation; STS: Society of Thoracic Surgeons

and the shortest hospitalization. (9)

MICS-Bentall is an increasingly popular procedure at cardiac surgery facilities worldwide. (10) Recently, Mikus et al. (8) published their experience in a retrospective study comparing patients who underwent aortic root surgery with full sternotomy versus minimal sternotomy, and they showed that the MICS group had lower mortality, shorter hospital length of stay, and early postoperative rehabilitation. However, minimally invasive approaches had longer ECC and ACC times.

In 2018, Abjigitova et al. published a retrospective study comparing 26 MICS-Bentall versus 91 Bentall under the full procedure, and they found no differences as regards ACC and ECC times or hospital length of stay. There was no death or reoperation from bleeding among the group of patients underwent MICS-Bentall. (11) In our group, despite the small sample size, there were no reoperations from bleeding, probably

Table 2. Intraoperative characteristics

| | |
|-------------------------------|--------------------------------|
| ECC time, min., mean \pm SD | 168.5 \pm 39.7 |
| ACC time, min., mean \pm SD | 126.5 \pm 15.3 |
| Blood transfusion, n | 1 |
| Platelet transfusion, n | 5 |
| Fibrinogen transfusion, n | 2 |
| ECMO, n | 0 |
| IABP, n | 0 |
| Prosthesis, n | Biological: 5 Mechanical: 5 |
| Cardioplegia | Blood: 7 Crystalloid: 3 |

ACC: aortic cross-clamping; ECC: extracorporeal circulation; ECMO: extracorporeal membrane oxygenation; IABP: intra-aortic balloon pump; SD: standard deviation

Table 3. Postoperative results

| | |
|--|---|
| Extubation within less than 6 hours, n | 5 |
| Atrial fibrillation, n | 1 |
| Wound infection, n | 1 |
| Total length of stay, days (mean) | 5 |

because of very careful hemostasis.

Our ECC and ACC times were similar to those in the literature. (8,11)

All our patients were electively operated under very careful planning. Cannulation over the aortic arch and peripheral vein has been essential for better exposure of the operative area after reducing elements within the surgical field.

In addition, there was no death after 30 days, and mean extubation and hospitalization was consistent with the condition.

As for hospital length of stay, 80% of our patients were discharged five days after surgery. As compared with other sites, the length of stay was similar. (12) This is because the minimally invasive procedure reduces trauma and pain in the rib cage, and, therefore, rehabilitation is rapid. (13)

Concerning the type of minimal (“J” or “T” shaped) sternotomy, in our experience, the T-shape approach provides better exposure when creating the ostium and enhanced dissection of the aortic root. The J incision is ideal for more simple procedures, such as aortic valve replacement or ascending aorta isolation. (12,14,15)

Some surgeons tend to open the right pleural chamber to avoid tamponade in case of bleeding, but we prefer not to do this, except if the pleura is inadvertently opened when using the sternal saw.

Following anastomosis of the ostium knob on the right coronary artery, we routinely insert Blake 24 French drainage over the xiphoid reflection, place the ventricular wires of epicardial pacemakers, and use 4 ml surgical sealant CoSeal® (BAXTER) over every

anastomosis and cannulation site. While CoSeal® (BAXTER) takes one minute, we prefer to wait three minutes for the gel to be properly formed over the anastomotic line.

A transesophageal echocardiogram is vital for this procedure, as it guides cannulation both centrally and peripherally, while providing postoperative monitoring. We performed intraoperative and post-ECC measurements using rotational thromboelastometry (ROTEM) throughout.

All patients had blockage close to sternotomy using a transverse chest plane on both sides at the T4-T5 level to manage postoperative pain. We believe this largely contributes to faster rehabilitation.

We also firmly believe that patients' and referring physicians' perceptions and expectations have changed, and surgeons should offer minimally invasive techniques as a valid therapeutic option. This requires not only surgical skills but also continuous training in the field. Our site has surgeons trained abroad at major sites and experienced in minimally invasive surgery.

Patients with a history of chest radiation, "porcelain aorta", reoperations, or severe mitral ring calcification are not good candidates for minimally invasive techniques, due to the complexity of small and hard to control incisions when complications occur.

Limitations

This is a retrospective single-center observational study with a small number of patients.

Conclusions

In our experience, minimally invasive surgery of the aortic root using minimal sternotomy has yielded promising results in terms of early mortality and morbidity. It is necessary to continue analyzing this procedure with a larger number of patients and a longer follow-up in the future.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web/Additional material.)

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