ORIGINAL ARTICLE

Experience with left heart bypass in descending aortic surgery

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Introduction. **Left heart bypass (LHB) was first described in 1957. Disruption of blood flow to the spinal cord and abdominal viscera contributes to the development of ischemic complications. The aim of this technique is to ensure distal organ perfusion to avoid ischemic complications during descending aortic surgery.** ***Objective.*** **We sought to demonstrate the efficacy and safety of the left bypass as circulatory assistance in descending aortic surgery by presenting our initial experience.** ***Material.*** **Fifteen patients with descending aortic pathology and undergoing surgery, were studied from April 2011 to December 2019. The age range was 13 to 74 years. The most common etiology was aortic coarctation. The serum lactate, serum creatinine and liver enzyme values were revised in preoperative, immediate postoperative and hospital discharge.** ***Results.*** **In all of cases the left heart drained was through left atrium an inflow cannula in the femoral artery (3 cases 20%) or distal aorta (12 cases 80%); the size of the graft ranged from 14 to 24 mm. The mean cross-clamp time was 48.1 minutes (range 38.5 to 88.1 minutes). There were no severe alterations in biochemical parameters after bypass and muscle strength was not affected in any of the patients. We did not have any complications. In follow-up to 6 months the patients are developing a normal life.** ***Conclusions.*** **LHB for repair of the descending aortic pathology allowing an accurate surgery without time pressure. We would recommend its use to increase the safety margin in the high-risk population especially in hospitals where we do not routinely have this type of surgery.**

Key words: **Aortic Surgery; Descending aorta surgery; Left heart bypass; Mexico.**

Intoducción. **El bypass izquierdo (BPI) se describió por primera vez en 1957. La interrupción del flujo sanguíneo a la médula espinal y las vísceras abdominales contribuye al desarrollo de complicaciones isquémicas. El objetivo de esta técnica es asegurar la perfusión de los órganos distales para evitar complicaciones isquémicas durante la cirugía de aorta descendente.** ***Objetivo.*** **Demostrar la eficacia y seguridad del bypass izquierdo (BPI) como asistencia circulatoria en la cirugía de aorta descendente presentando nuestra experiencia inicial.** ***Material.*** **Se estudiaron quince pacientes con patología de aorta descendente y sometidos a cirugía de abril de 2011 hasta diciembre de 2019. El rango de edad fue de 13 a 74 años. La etiología más común fue la coartación aórtica. Los valores de lactato sérico, creatinina sérica y enzimas hepáticas se revisaron en el preoperatorio, postoperatorio inmediato y al alta hospitalaria.** ***Resultados.*** **En todos los casos el drenaje del BPI fue a través de la aurícula izquierda y una cánula de entrada en la arteria femoral (3 casos 20%) o aorta distal (12 casos 80%); el tamaño del injerto osciló entre 14 y 24 mm. El tiempo medio de pinzamiento fue de 48,1 minutos (rango de 38.5 a 88.1 minutos). No hubo alteraciones graves en los parámetros bioquímicos tras el bypass y la fuerza muscular no se vio afectada en ninguno de los pacientes. No tuvimos ninguna complicación. En el seguimiento a los 6 meses, los pacientes están desarrollando una vida normal.** ***Conclusiones.*** **El BPI para la reparación de la patología de aorta descendente permite una cirugía precisa sin presión de tiempo. Recomendamos su uso para aumentar el margen de seguridad en la población de alto riesgo, especialmente en hospitales donde no tenemos de forma rutinaria este tipo de cirugía.**

Palabras clave: **Cirugía Aórtica; Cirugía de Aorta Descendente; Bypass izquierdo; México.**

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Left heart bypass (LHB) to protect the spinal cord in patients undergoing operations on the thoracic aorta was first described in 1957 [1,2]. Disruption of blood flow to the spinal cord and abdominal viscera contributes significantly to the development of ischemic complications. Conversely, maintaining flow through spinal and visceral arteries during all or part of the anatomic repair of descending aortic disease, should reduce the duration of organ ischemia and prevent associativity [3].

The LHB to ensure distal organ perfusion to avoid ischemic complications during descending aortic surgery. The left atrial appendage is cannulated for drained and the left common femoral artery or the distal descending aorta is used for distal perfusion.

We have implemented LHB surgery in descending aortic surgery, our series has fifteen cases with excellent results.

MATERIAL

A total of fifteen patients with descending aorta pathology and undergoing surgery, were studied from April 2011 to December 2019. The male sex accounted for 60% of the total, the age range was 13 to 74 years (median, 33). The most common etiology was aortic coarctation and one of them was re- coarctation (first surgery was 45 years ago) We had three patients with urgent aortic rupture, two of them post-traumatic and another with juxtaductal aneurysm rupture associated with aortic coarctation (**Table 1**). The serum lactate, serum creatinine and liver enzyme values were revised in preoperative, immediate postoperative and hospital discharge.

Table 1. Causes of Descending Aortic Surgery

PATHOLOGY	Number of cases
Traumatic	02
Reoperation for aortic coarctation	01
Descending aortic aneurysm	01
Aortic coarctation and aneurysm	01
Aortic coarctation and ruptured aneurysm	01
Aortic coarctation	09
Total	15

Surgical technique

The aim of the LHB is to ensure distal organ perfusion to avoid ischemic complications during descending aortic surgery. This procedure has been previously described by several authors. Our patients were intubated with a double-lumen endotracheal tube and positioned for a left posterolateral thoracotomy. A fourth interspace posterolateral thoracotomy was performed; the perfusion circuit consisted of an outflow cannula in the left atrium an inflow cannula in the femoral artery or distal aorta; 3/8-inch polyvinyl chloride tubing; and a centrifugal pump; The left heart was drained through a 28F to 32F right-angle venous cannula, and an 18F to 20F femoral or aortic artery perfusion cannula was used to provide arterial inflow. Distal aortic perfusion was maintained at a pressure of 60 to 75 mm Hg. Flow rates ranged from 1.5 to 3.0 L/min. A prosthetic graft was used in all cases to replace that segment of the injured aorta (**Fig. 1**).

We decided for LHB in patients with complex descending aorta pathology and who would demand more aortic cross clamp time.

RESULTS

The LHB was successful in all 15 patients without perioperative complications. In all of cases the left heart drained was through left atrium an inflow cannula in the femoral artery (3 cases 20%) or distal aorta (12 cases 80%). The size of the graft ranged from 14 to 24 mm (**Fig. 2**). The mean cross-clamp time was 48.1 minutes (range 38.5 to 88.1 minutes). There were no severe alterations in biochemical parameters after bypass and muscle strength was not affected in any of the patients (**Table 2**). We did not have any complications. In follow-up to 6 months patients find themselves without any sequelae and developing normal life.

DISCUSSION

The two central issues associated with prevention of paraplegia are the duration of cross-clamp time and use of distal aortic perfusion. Kirklin et al. [4] showed in 1981 that ischemic times >30 minutes are associated with the development of postoperative paraplegia. This has been validated in several larger series of patients [5,6]. Normothermic ischemia times exceeding 30 minutes result in an exponentially increasing incidence of paraplegia. In addition, paraplegia can occur with clamp times of <30 minutes, especially when there is perioperative hypotension. The Gott shunt was developed to provide distal aortic perfusion, but the device is not simple to insert, and flow through the shunt cannot be precisely controlled or measured.

The paraplegia is the most feared complication following coarctation repair because of the devastating consequences for the young patient's quality of life. Fortunately, it occurs very rarely in neonates and infants [7]; however, it is of great concern that the reported incidence in older children or adults. On the other hand, after repair of descending aortic transection surgery the paraplegia is the most devastating complication too. Most of the patients who have blunt aortic injury are young, the personal loss caused by paraplegia and the economic impact on society are devastating. Earlier reports have documented the development of paraplegia in approximately 2.9% to 20% of patients after repair, as the result of spinal cord

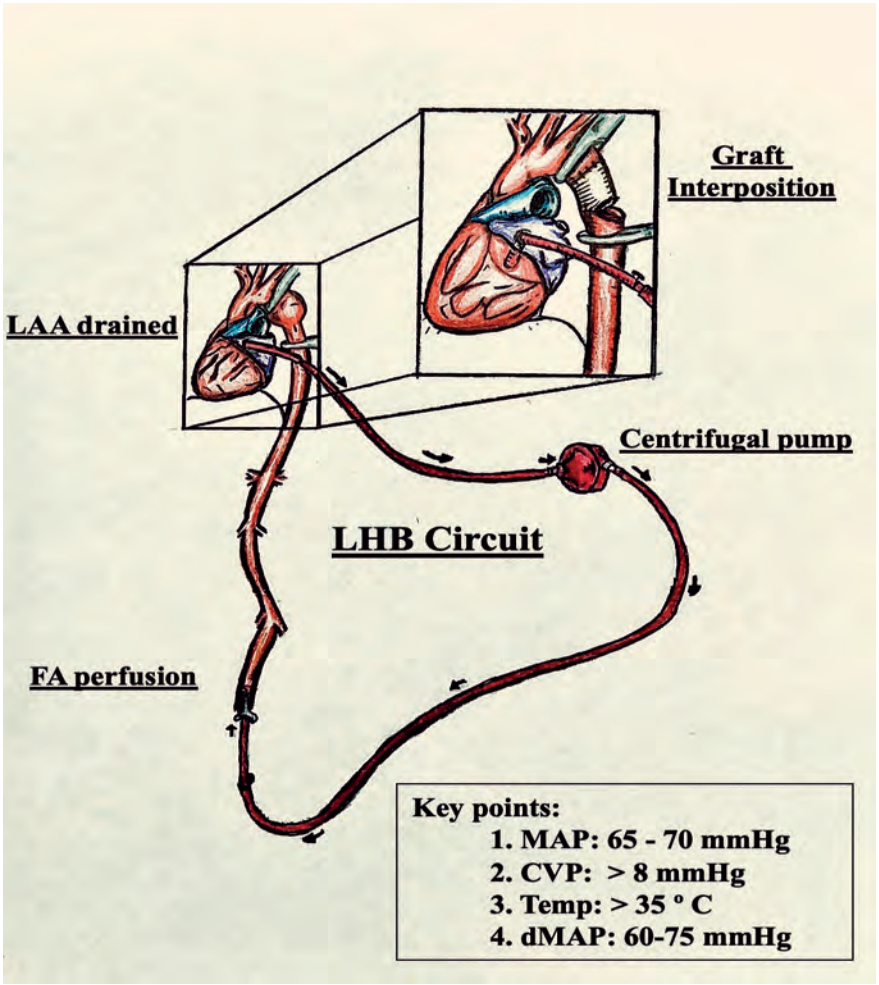

Figure 1. Left heart bypass scheme with atrio-femoral cannulation. Distal perfusion can be performed through the descending aorta. Abbreviations: LAA: Left atrial appendage; LHB: Left heart bypass; FA: Femoral artery; MAP: Mean arterial pressure; CVP: Central venous pressure; TEMP: Temperature; dMAP: Distal mean artery pressure

ischemia; the incidence of paralysis after simple cross-clamping may be as high as 20% [8]. Our series has adult patients with diverse aortic complex pathology and our experience in descending aorta surgery it not very extensive, for that reason we used the LHB in avoid the paraplegia. Coselli et al. [9] published a paper with 710 cases recommending the use of LHB to avoid spinal cord injuries in thoracoabdominal aortic surgery; four years after, they concluded [10] in an article with 380 patients, that LHB does not reduced the incidence of paraplegia, they used the "clamp and sew" technique, they do many descending aortic surgery and the experience in this type of surgery is the principal factor that permit avoid the LHB without any complications.

Another measure to monitor adequate spinal cord perfusion during left heart bypass is the continuous measurement of cerebrospinal fluid (CSF) pressure, this maneuver is described in very extensive surgeries such as correction of thoracoabdominal aneurysm [3]. The CSF is allowed to drain passively from the catheter and can be aspirated with a closed collection system as needed to keep the CSF pressure between 8 and 10 mm Hg during the operation and between 10 and 12 mm Hg during the early postoperative period. We did not use this technique in any of our cases, we considered that surgery would not have long aortic cross clamping time.

The incidence of renal failure necessitating hemodialysis has been reported in thoracoabdominal surgery with LHB of 5.7% and there are no reports of liver failure [3]. We measure serum levels of creatinine, lactate and liver enzymes to assess distal organic perfusion during left bypass. We found no major alterations; it was even observed in the 3 patients with aortic rupture, improvement in the immediate postoperative period of the serum levels of these substances.

Table 2. Biochemical Parameters

VARIABLE	Preoperative	Postoperative	Hospital discharge
Lactate	1.2 (0.9-3.3)	1.7 (1.1-3.1)	1.1 (0.9-1.6)
Total bilirubins	0.33 (0.25-0.88)	1.77 (1.2-2.4)	0.9 (0.7-1.66)
Direct bilirubin	0.11 (0.07-0.59)	0.11 (0.09-0.45)	0.10 (0.09-0.42)
Indirect bilirubin	0.25 (0.18-0.77)	1.18 (0.82-1.76)	0.7 (0.4-1.33)
LDH	306.4 (218-490)	716.7 (634.5-918.4)	397.6 (365-554.4)
AST	20.1 (18.3-38.5)	65.4 (52.3-78.7)	35.8 (29.9-44.3)
ALT	35.8 (29.4-51.1)	32.5 (29.4-36.5)	33 (28.5-36.3)
Creatinine	1.2 (0.8-2.2)	1.4 (0.9-1.7)	1.3 (1.1-1.59)

DHL: Lactic dehydrogenase; AST: Aspartate aminotransferase; ALT: Alaninoaminotransferase

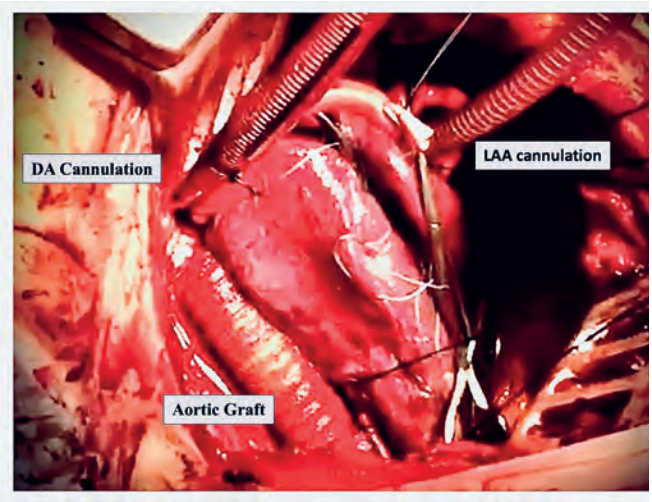

Figure 2. Example. Aortic coarctation of a 33-year old male patient. Abbreviations: LAA; Left atrial appendage; DA: Distal aorta

As conclusion we have shown that LHB can be carried out quickly, simply and safely. It maintains spinal cord perfusion during descending aorta surgery and minimizes any ischaemic insult. Repair of the descending aortic pathology can then proceed properly, allowing an accurate repair without time pressure. We recommend its use to increase the safety margin in the high-risk population especially in hospitals where we do not routinely have descending aortic surgery.

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