ORIGINAL ARTICLE

Minimally Invasive Cardiac Surgery. An Institutional Program

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Minimally invasive cardiac surgery (MICS) has been developed since the nineties. Actually, it is solving the majority of cardiac surgical problems in adults. *Material.* We present a retrospective study carried out in the Unidad Médica de Alta Especialidad No 71, Instituto Mexicano del Seguro Social, between 2015 and 2019 with 116 patients divided as follows. Group A, with 58 patients treated with MICS, 30 aortic procedures were performed, sixteen mitral procedures, one tricuspid procedure, 6 atrial septal defects repairs, and one pacemaker lead extraction were performed, and finally 4 coronary artery bypass grafting surgeries . Group B, with 58 patients treated with conventional cardiac surgery for complete sternotomy, with similar number of cases, diagnosis and procedures. *Results.* Both groups showed similarities regarding co-morbidities. However, with a significant difference for smoking (p= 0.022) and hypertension (p=0.009) in Group A. The extracorporeal circulation time in Group A was 112 min and in the Group B of 80 min, respectively (p= 0.00). Aortic clamping in Group A was 92 min and in Group B it was 69 min (p= 0.003). Total postoperative complications were greater in surgery performed by conventional sternotomy (Group B) than in patients operated by MICS (Group A). The post-operative length of stay was shorter in Group A. *Conclusions.* MICS technique in this study proved to be feasible in our public health system. Minimally invasive surgery showed longer time for extracorporeal circulation and aortic clamping but fewer complications and postoperative length of in-hospital stay.

Key words: **Coronary artery bypass grafting; Minimally Invasive Cardiac Surgery (MICS); Heart valve surgery.**

La cirugía cardíaca mínimamente invasiva (MICS) se ha desarrollado desde los años noventa. Actualmente resuelve la mayoría de los problemas quirúrgicos cardíacos en adultos. *Material.* Presentamos un estudio retrospectivo realizado en la Unidad Médica de Alta Especialidad No. 71 del Instituto Mexicano del Seguro Social entre 2015 y 2019 con 116 pacientes divididos en dos grupos. Grupo A con 58 pacientes tratados con MICS, se realizaron 30 procedimientos aórticos, dieciséis procedimientos mitrales, uno tricúspide, seis reparaciones de comunicación interauricular, una extracción de cable de marcapasos y finalmente cuatro cirugías de derivación coronaria. Grupo B con 58 pacientes tratados con cirugía cardíaca convencional por esternotomía completa, con igual número de pacientes, diagnósticos y procedimientos. *Resultados.* Ambos grupos mostraron similitudes en cuanto a comorbilidades, sin embargo, con una diferencia significativa en la presencia de pacientes con tabaquismo (p=0.022) e hipertensión (p=0.009) en el Grupo A. El tiempo de circulación extracorpórea en el Grupo A fue de 112 min y en el Grupo B de 80 minutos (p= 0.001). El pinzamiento aórtico en el Grupo A fue de 92 min y en el grupo B fue de 69 min (p =0.003). Las complicaciones postoperatorias totales fueron mayores en la cirugía realizada por esternotomía convencional (Grupo B) que en los pacientes operados por MICS (Grupo A). El tiempo de estancia intrahospitalaria postoperatoria fue menor en el Grupo A. *Conclusiones.* La técnica de MICS en este estudio demostró ser factible en nuestro sistema de salud pública. La cirugía mínimamente invasiva mostró mayor tiempo de circulación extracorpórea y pinzamiento aórtico, pero menos complicaciones y días de estancia intrahospitalaria.

Palabras clave: **Revascularización coronaria; Cirugía Cardiaca Mínimamente Invasiva; Cirugía valvular cardiaca.**

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Minimally invasive cardiac surgery (MICS) is considered to have been performed for the first time by José L. Navia et al. for mitral valve surgery with a right parasternal incision in 1996 [1]. Subsequently Lawrence H. Cohn performed parasternal incisions or ministernotomy for aortic valve surgery and for mitral valve surgery with parasternal incisions in 1997 [2]. Delos M. Cosgrove III in 1998 described procedures for isolated mitral valve and simultaneous procedures of mitral and aortic valves through a right parasternal incision [3].

In the early days of cardiac surgery, standard right thoracotomy was used by Walton Lillehai in 1956 to perform mitral valve surgeries, and in the 1990s it was used to repair atrial septal defects and aortic valve implants as an alternative to standard sternotomy [4,5].

Alain Carpentier performed the first video-assisted mitral valve repair in 1996. Randolph Chitwood performed the first mitral replacement by right mini thoracotomy in the same year. In 1998 Friedrich W. Mohr reported the first series of mitral replacements and repairs through the Port Access endovascular cardiopulmonary bypass system through right mini thoracotomy. Based on all these antecedents and the advances in perfusion techniques, the right mini-thoracotomy has taken on relevance in order to reduce surgical aggression in cardiac surgery and it has been adopted by many surgeons for the resolution of almost all valve pathologies [6-8]. On the other hand, reports of atrial septal defects repairs in adults and procedures on the tricuspid valve performed by right mini thoracotomy are still scarce.

Regarding the approach to ischemic heart disease, Joseph McGinn reported in 2009 the first work on minimally invasive coronary artery bypass grafting by left min-thoracotomy [9].

The best concept of MICS is still under development and discussion. The establishment of programs are still scarce and requires a slow and careful process. We present in this paper the experience of establishing a MICS program within a public institution in Mexico.

MATERIAL

This work was carried out in Unidad Médica de Alta Especialidad No. 71 of Instituto Mexicano del Seguro Social, from 2015 to 2019. It is a comparative retrospective study with a total amount of 116 patients divided into two groups: *Group A* consisted of 58 patients treated by MICS: These patients were operated on by mini-sternotomy, right mini-thoracotomy, and left mini-thoracotomy. Forty-seven with diagnoses of valve disease; 30 with aortic valve disease, 16 with mitral valve disease and one with tricuspid regurgitation. The additional procedures of the patients with tricuspid valve disease were due to endocarditis or associated with mitral valve disease. We also had six patients with atrial septal defects and one endocarditis due to infected endocardial pacemaker leads. Also, we had 4 patients with ischemic heart disease who underwent off pump coronary artery bypass graft, all of them with left internal mammary artery to the anterior descending artery throughout left anterior mini-thoracotomy. *Group B* with 58 patients treated by conventional median sternotomy with the same number of aortic, mitral and tricuspid valve pathologies. Tricuspid valve additional procedures were due to endocarditis or associated with mitral valve disease. In addition to equal number of corrections of atrial septal defects and endocarditis due to endocardial pacemaker leads. Finally, 4 patients with ischemic heart disease who underwent coronary revascularization with a left internal mammary artery in the territory of the anterior descending artery in all cases.

Age, gender, co-morbidities such as obesity, diabetes mellitus, arterial hypertension, smoking, renal, pulmonary or hepatic dysfunction and hypothyroidism, cardiological diagnosis and type of surgery were evaluated. Extracorporeal circulation time, and aortic clamping, postoperative evolution and days of hospital stay were also analyzed.

1. The surgical technique for approaching the aortic valve was performed in two ways:

a) Mini-sternotomy. With the patient in the supine position, placement of a radial arterial line, central catheter, external defibrillation patches, and an established protocol for induction and anesthetic management are performed. With limited skin incision of 8 to 10 cm and mini "T" sternotomy up to the 4th intercostal space. Central cannulation, extracorporeal circulation and antegrade cardioplegia are performed with Custodiol. Aortotomy and aortic valve implant with mechanical or biological aortic valve as standard.

b) Right mini-thoracotomy. With the patient in the supine position, a radial arterial line, central catheter, external defibrillation patches, anesthetic induction, and intubation with a single lumen endotracheal tube are placed. Right femoral venous and arterial cannulation is performed with a limited incision in the right groin region. An anterior right mini-thoracotomy incision is made with a 5 to 7 cm incision in the third right intercostal space, following the Miami Method strategy for the aortic valve A soft tissue retractor is placed and the pericardium is opened and referred. Reference and exposure sutures are placed in the pericardium, and a purse-string is placed in the aorta for antegrade cardioplegia. Extracorporeal circulation is started with vacuum assistance and the aorta is clamped with a flexible and retractable aortic clamp. Cardioplegia with Custodiol and hypothermia at 28°C, transverse aortotomy and aortic valve implant with mechanical prosthesis or biological prosthesis with separate suture. An epicardial pacemaker and drainage tubes are placed in the right hemithorax and closed as usual.

2. The surgical technique for approaching the mitral valve was performed by right mini thoracotomy following the *Miami Method* strategy for minimally invasive mitral valve surgery. With the patient in the supine position and elevation of the right hemithorax, placement of the radial arterial line, central catheter, external defibrillation patches, anesthetic induction and intubation with a single lumen endotracheal tube are performed. It begins with right femoral arterial and venous cannulation with a limited incision in the right groin

region. A right mini-thoracotomy incision is made with a 5 to 7 cm incision at the level of the 4th right intercostal space below the breast groove. A soft tissue retractor is placed and reference and exposure sutures are placed in the pericardium. Purse-string suture is placed in the aorta for antegrade cardioplegia. Extracorporeal circulation is started with vacuum assistance and the aorta is clamped with a flexible and retractable aortic clamp. Cardioplegia with Custodiol and hypothermia at 28 degrees centigrade is applied. The left atrium is opened and an intra-atrial retractor is placed through a counter-opening throughout the right sternal side to expose the mitral valve. The mitral valve is changed or repaired and the left atrium is closed. An epicardial pacemaker and drainage tubes were placed in the right hemithorax and closed as usual (**Fig. 1**) (**Fig. 2**).

3. The surgical technique for the right atrium approach was similar for tricuspid valve replacement or repair, atrial septal defects repair and removal of pacemaker leads with tricuspid endocarditis. The right minithoracotomy incision is made with 5-7 cm incision at the level of the 4th right intercostal space below the breast grove. Femoral cannulation and right thoracotomy were performed in a similar and complementary manner to the mitral valve approach; however, to open the

TABLE 1. Demographic variables, comorbidities and preoperative diagnosis

	Group A N=58 MICS	Group B N=58 Standard Sternotomy	Chi²	p value
Age	55 ± 12.16 years	53 years ± 13.56 years		0.491
Weight	78 ± 13.84 kg	79 ± 13.11 kg		0.191
Male	29	34	0.869	0.351
Female	29	24		
Hypertension	37	23	6.77	0.009
Diabetes mellitus	20	22	0.149	0.699
Obesity	23	20	0.333	0.564
Dislipidemic	21	19	.153	0.696
Smoking	17	7	5.25	0.022
Chronic Obstructive Lung Desease	7	4	0.904	0.342
Renal Insuficiency	4	1	1.881	0.170
Cerebrovascular Desease	3	5	0.537	0.464
Hepatic Insuficiency	1	1	0.000	1.00
Hipothyroidism	3	3	0.000	1.00
Cardiac failure	1	2	0.342	0.559
Aortic Insufficiency	10 (2 END,1SAR,1VSD)	13 (1 SAR , 3 END)		
Aortic Mixed Lesion	6	4		
Aortic Stenosis	14 (1 SAR)	13		
Mitral Stenosis	3	2		
Mixed Mitral Lesion	8 (5 TI)	9 (TI)		
Mitral Insuficiency	5 (1 TI)	5 (2 TI, 1 END)		
Tricuspid Insuficiency	1	1		
Atrial Septal Defect	6	6		
Pacemaker Endocardic Infection	1	1		
Ischemic Cardiopathy	4	4		
Left Ventricle Ejection Fraction	55 .9% ± 11.36	56.58 % ± 10.62		0.743
NYHA I	6	9	12.9%	
II	32	34	56.9%	
III	18	11	25.0%	
IV	2	4	5.2%	

SAR : SubAortic Ridge, TP: Tricuspid Insufficiency , END: Endocarditis , NYHA : New York Heart Association.

right atrium it was necessary to isolate and refer the superior and inferior vena cava. Before opening the right atrium, the inferior venous cannula is moved into the inferior vena cava below the right atrium and occluded with cotton tapes. The right atrium is opened and a 22 Fr left chamber drainage tube is introduced into the superior vena cava, isolating it with cotton tape, achieving a dry field. We then proceed to perform a plasty or change of the tricuspid valve, removal of infected pacemaker leads, or closure of the atrial septal defects with a bovine pericardial patch. The right atrium is closed, an epicardial pacemaker lead and chest drainages are placed, and it is closed in the usual manner.

4. Surgical technique for coronary artery bypass graft off pump was performed through a 10 cm left thoracotomy in the fourth left intercostal space below the left nipple. A special retractor Thoratrac like is placed for dissection of the left mammary artery, then the pericardium is opened and referred. A stabilizer is placed over the anterior descending line and a distal anastomosis of the mammary is performed as usual. A pacemaker and chest drain tubes are placed, and the chest wall is closed in the usual manner (**Fig. 2**). In all cases with the use of CO2 as a deairing strategy in the operative field and in extracorporeal circulation, vacuum assistance.

RESULTS

In Group A, the average age was 55 years, with an average weight of 78 kg. There were 29 men. The co-morbidities profile in both groups showed patients with hypertension, obesity, dyslipidemic, smokers, with chronic obstructive pneumopathy and renal failure. A higher prevalence of hypertension and smoking higher in group A than Group B, p= 0.009 and p= 0.022, respectively. Left ventricle ejection fraction was 55.9% and NYHA functional class was mainly II or III. There were 30 patients with diagnosis of aortic valve disease; out of them, 14 aortic stenosis, 10 aortic insufficiencies, and 6 mixed aortic lesions.

There were 16 patients with diagnosis of mitral valve diseases; 8 as mixed lesions, 5 mitral insufficiency, and 3 mitral stenosis. Of them, 6 required tricuspid plasty due to associated secondary tricuspid regurgitation.

One isolated tricuspid regurgitation, one endocardial pacemaker infection, 6 interatrial septal defects, and 4 coronary insufficiencies (**Table 1**).

From 58 cases, 30 aortic valve replacements implants were performed; 18 mini sternotomy and in two of these cases a subaortic ridge resection and one ventricular septal defect repair. The remaining 12 patients underwent aortic valve implant through a right mini thoracotomy. The mitral valve procedures were all performed by right mini thoracotomy. There were 16 patients, 10 with isolated valve implants and 5 mitral valve replacements plus tricuspid valve repair, and one combined as mitral and tricuspid repair. The procedures performed in the right atrium were by right mini-thoracotomy. Six ostium secundum-type atrial septal defects were repaired, one tricuspid valve replacement was performed, and one case with removal of an endocardial pacemaker lead. Four coronary artery bypass graft without pump were performed by left mini-thoracotomy in the territory of the anterior descending artery (**Table 2**).

In Group B, 58 procedures were performed, all for standard sternotomy. There were 34 men and 24 women, with an average of 53 years-old. This group showed to have more men, diabetic patients and cerebrovascular disease. The left ventricle ejection fraction averaged of 56.5%, and a NYHA functional class II-III. There were 30 patients with diagnosis of aortic valve disease; 13 aortic stenosis, 13 aortic insufficiencies, and 4 mixed lesions. There were 16 patients with diagnosis of mitral valve diseases; 9 mixed mitral lesions, 5 mitral regurgitation, and 2 as single mitral stenosis. Of these 16 cases, 3 required tricuspid valve repair for tricuspid regurgitation. In addition, one isolated tricuspid regurgitation, one endocardial pacemaker infection, and 6 interatrial septal defects (**Table 1**). Thirty aortic valve implants were performed, in which one case included a sub valvular aortic ridge resection, and one case as tricuspid valve replacement. There were 16 mitral valve replacements; in five of which a tricuspid valve repair was also performed. Six ostium secundum-type atrial septum defects were repaired, a tricuspid valve replacement was performed, an infected endocardial pacemaker lead resection, and finally 4 cases of coronary artery bypass graft off pump in the anterior descending region (**Table 2**).

DISCUSSION

The American Society of Thoracic Surgeons defined minimally invasive cardiac surgery in 2003 as "any procedure not performed with a complete sternotomy and cardiopulmonary bypass support." However, in 2008, the American Heart Association defined minimally invasive cardiac surgery "as a small incision in the chest wall that does not include a conventional complete sternotomy."

Mattia Glauber considers that the term MICS should not be related to a specific procedure but rather to a "concept" or a "philosophy" that requires a specific operating strategy whose objective is to reduce the degree of surgical invasiveness [11].

The establishment of a MICS program requires the construction of a multidisciplinary team that is willing to learn "new languages, new ways of visualizing the heart," a team that encourages collaboration and creativity to solve problems. That it is made up of at least two surgeons, perfusionists, anesthesiologists, cardiologists and nurses who learn to see this technique as a tool and an advantage.

In every new program there is a learning curve that you have to be willing to go through, the team must become familiar with instruments other than those used with standard surgery, not to see the heart as we usually see it and, in any case, collaborate and see the procedure through a monitor. For our institutional reality, we consider that the technique proposed by Dr. Joseph Lamelas called "Miami Method" is the most accessible and practical. It does

TABLE 2. Performed procedures

	Group A N=58 MICS			Group B N=58 Standard Sternotomy
Procedures Performed	**MS**	**RMT**	**LMT**	**Sternotomy**
Aortic Valve Surgery		30		30
Aortic Valve Prosthesis	15	12		28
Aortic Valve Prosthesis + Sub Aortic Valve Ridge Resection	2			1
Aortic Valve Prosthesis + Ventricular Septal Defect Repair	1			1
Total	18	2		30
Implanted Prosthetic Valves	22 Mechanic/ 8 Biological			23 Mechanic / 7 Biological
Mitral Valve Surgery		16		16
Isolated Mitral Valve Prosthesis		11		11
Mitral Valve Prosthesis+ Tricuspid Repair or Tricuspid Prosthetic Valve		4		5
Mitral Valve Repair + Tricuspid Valve Repair		1		1
Total		16		16
Implanted Prosthetic Valves	12 Mechanic / 3 Biological/ 1 Mitral Ring			13 Mechanic/ 4 Biological
Tricuspid Valve Surgery		1		1
Tricuspid Valve Prosthesis		1		1
Total		1		1
Implanted Prosthetic Valves	1 Biological			1 Biological
Atrial Septal Defect Repair		6		6
Total		6		6
Infected Pacemaker Lead Removal		1		1
Total		1		1
Off Pump Coronary Artery Bypass Grafting			4	4
Total			4	4
N (number of cases)	58			58
Extracorporeal Circulation Time (min)	112			80 (p= 0.001)
Aortic Clamping Time (min)	92			69 (p= 0.001)
Total of Implanted Prosthetic Valves	46 Valves (34 Mechanic / 12 Biological/ 1 Mitral Ring)			48 Valves (36 Mechanic / 12 Biological)

MS: Ministernotomy; RMT: Right Minithoracotomy; LMT: Left Minithoracotomy.

not require thoracoscopy equipment, it is performed under direct vision, with trans-wound aortic clamping and a femoral perfusion platform, giving the opportunity to be much more reproducible.

Any surgeon who wants to be a part of this technique should be comfortable with conventional open surgery and convert minimally invasive surgery to sternotomy when necessary. Minimally invasive cardiac surgery has advantages, better cosmetic results, shorter in-hospital and intensive care unit length of stay. Also, better and faster patient mobility, less bleeding and infections, and eventually lower cost.

There is resistance to break the "status quo" on or daily practice, nonetheless a state of commotion is needed in order to modify our surgical duty to became part of progress on cardiac surgery.

In this work carried out in our institution, we compared MICS (Group A) with respect to cardiac surgery performed in a conventional way for complete sternotomy (Group B) from 2015 to 2019.

The analysis of these groups showed that the preoperative demographic characteristics of both are similar without statistically significant differences in terms of age, weight and similar expulsion fraction also in the number of cases of diabetes mellitus II, dyslipidemia and obesity. However, it should be noted that patients treated with minimally invasive (Group A) have a higher prevalence of hypertension (p= 0.009) and smoking (p= 0.022) than those operated by standard sternotomy (Group B). Regarding the preoperative organic dysfunctions (pulmonary, cardiac, renal, cerebral, hepatic and hypothyroidism) there was no difference between both groups. The NYHA functional class was similar in both groups, most of them in functional class II and III.

In this series, all scheduled procedures for each pathology in both groups were performed with both the conventional technique and the minimally invasive technique. The diagnosis of Group A and B were similar, some with complementary procedures such as some aortic valves that also presented subaortic ridge or interventricular communications that were resolved in the same procedure. Also, mitral valve disease with severe tricuspid insufficiencies that were approached in the same procedure with tricuspid plasties.

In Group A, 58 patients were operated, 30 aortic procedures with 18 mini sternotomies and 12 right mini thoracotomies, 22 mechanical valves and 8 biological valves were placed. A mini-sternotomy also performed a subaortic ridge resection and a ventricular septal defect repair. Sixteen mitral valve procedures, 11 isolated valve implants, all mechanical prostheses. Four valve implants with tricuspid valve plasties, three biological valves and one mechanical valve were placed. Finally, a mitral valve plasty with ring No. 28 and tricuspid plasty. A total of 46 valves were placed (12 biological valves, 34 mechanical) and one mitral annulus.

In Group B, 58 patients were operated, 30 aortic valve procedures with 7 biological prostheses and 23 mechanical prostheses, 28 isolated procedures and, in two cases, also the resection of a subaortic ridge and one tricuspid valve repair. In the mitral valve, 16 procedures were performed, 11 isolated valve changes with 2 biological and 9 mechanical prostheses. Four mitral valve implants with tricuspid valve repair, one biological and 3 mechanical prostheses were placed. A mitral valve replacement and one tricuspid valve replacement were performed simultaneously, where a mechanical mitral prosthesis and one biological prosthesis were placed in the tricuspid position. A total of 48 valves were implanted, out of them 12 as biological and 36 as mechanical prostheses (**Table 2**).

TABLE 3. Postoperative follow-up.

	MICS (58)	Standard Sternotomy (58)	x^2	*p*	OR	IC
Complications	17	25	2.389	0.122	1.827	0.848-3.93
Mediastinal Bleeding	3	8	2.511	0.133	2.93	0.733-11.67
Cardiac Failure	9	11	0.242	0.623	1.275	0.484-3.35
Pulmonary Failure	4	3	0.152	0.692	0.736	0.157-3.44
Hepatic Failure	1	0	1.009	0.315		
Renal Insuficiency	3	2	0.209	0.648	0.655	0.105-4.705
Stroke	3	1	2.009	0.366		
Sepsis	1	4	1.881	0.170	4.22	0.457-38.98
Delirium	0	3	3.080	0.079	.487	0.403-.588
Discharge	50	45	1.454	0.288	1.302	0.474-3.577
Death	8	10	0.263	0.608	1.302	474-3.577
Hospitalization	9.88	10.75				

MICS: Minimal Invasive Cardiac Surgery

MICS procedures have been reported since the late 1990s, starting with mitral and aortic procedures as well as limited left anterior thoracotomy procedures for coronary artery bypass graft with MIDCAB or minimal invasive direct coronary bypass procedures. The platforms for extracorporeal circulation have been various and have evolved, from central cannulation, open or percutaneous femoral cannulation, mixed or heart port.

Regarding aortic and mitral replacements, they have been approached by minimal invasion by European schools such as the Van der Merwe experience in Belgium, Leipzig with Sven Lehmann or Mattia Glauber in Italy with thousands of cases to date with excellent results. In the United States, the experience by Joseph Lamelas has been extensive with thousands of cases operated with single or double valvular minimally invasive procedures. These experiences have been enriched by the use of new sutureless valves or valve fixation devices that have made the results even better every day [12-20].

In this work, six corrections for ostium secundum-type atrial septal defects were made in each group. In Group A, they were made by right mini thoracotomy and a bovine pericardium was used for the correction because it is easier to handle in the mini thoracotomy. In the Group B, autologous pericardium was used in the correction (**Table 2**).

Reports of the correction of the atrial septal defects in adults by right mini-thoracotomy are scarce. Most are reports of pediatric patients through inferior mini sternotomy or sub mammary or axillary approaches. Chu et al. in 2014 reported a closure of 51 atrial septal defects in adults with ostium secundum type and venous sinus with jugular and femoral venous cannulation [21].

In our study in Group A, the right atrium was approached with a single femoral venous cannulation and direct drainage of the superior vena cava according to the Lamelas technique. In addition, a resection of the endocardial pacemaker leads and a change of the tricuspid valve per group were performed in this manner.

Four coronary artery bypass graft procedures were performed off pump, they were performed by left mini thoracotomy in the territory of the anterior descending artery without difference in length of stay and postoperative evolution compared to the control group. The mobility of minimally invasive patients was better and faster than the control group.

Joseph McGinn in 2009 reported for the first time a sries of 450 cases performed by left mini thoracotomy as an alternative for multivessel revascularization, with minimal reconversions, re-interventions and mortality. This technique has gradually gained relevance for coronary revascularization with groups in Japan with Keita Kikuchi and in Canada with Marc Ruel, opening the possibility of performing complete revascularization procedures or hybrid revascularization with interventional cardiology by revascularizing the lateral faces of the heart and leaving the artery descending anterior for minimally invasive surgical revascularization [22-24].

Extracorporeal circulation time is 40% longer in minimally invasive procedures with 112 min in Group A and 80 min in Group B (p= 0.001). Aortic clamping was longer in Group A with 92 min than Group B with 69 min (p= 0.003). However, there were no more postoperative complications in MICS compared to conventional surgery. These findings have been previously described by several groups without having an impact on the evolution of patients in large series. In fact, the number of complications detected was higher in Group B with 43% versus 29% in Group A.

Among the postoperative complications, bleeding, heart failure, sepsis and psychiatric complications have a higher prevalence in Group B of standard sternotomy. Nevertheless, they were not significant. Hospital discharges and deaths did not have a significant difference (**Table 3**).

In addition, the aesthetic results and early mobility in the mini-sternotomy, right and left mini-thoracotomy approaches were better than conventional surgery, as well as a shorter in-hospital length of stay. Our sample is still small but the advantages of MICS are evident, as shown in the photographs of the different types of approaches for MICS in **Fig. 3.**

The MICS technique in this study proved to be feasible, feasible with the same group of patients as conventional cardiac surgery, even more so with more complex patients, who despite having longer extracorporeal circulation time and aortic clamping showed fewer complications and shorter length of stay days as well as excellent cosmetic result than conventional surgery.

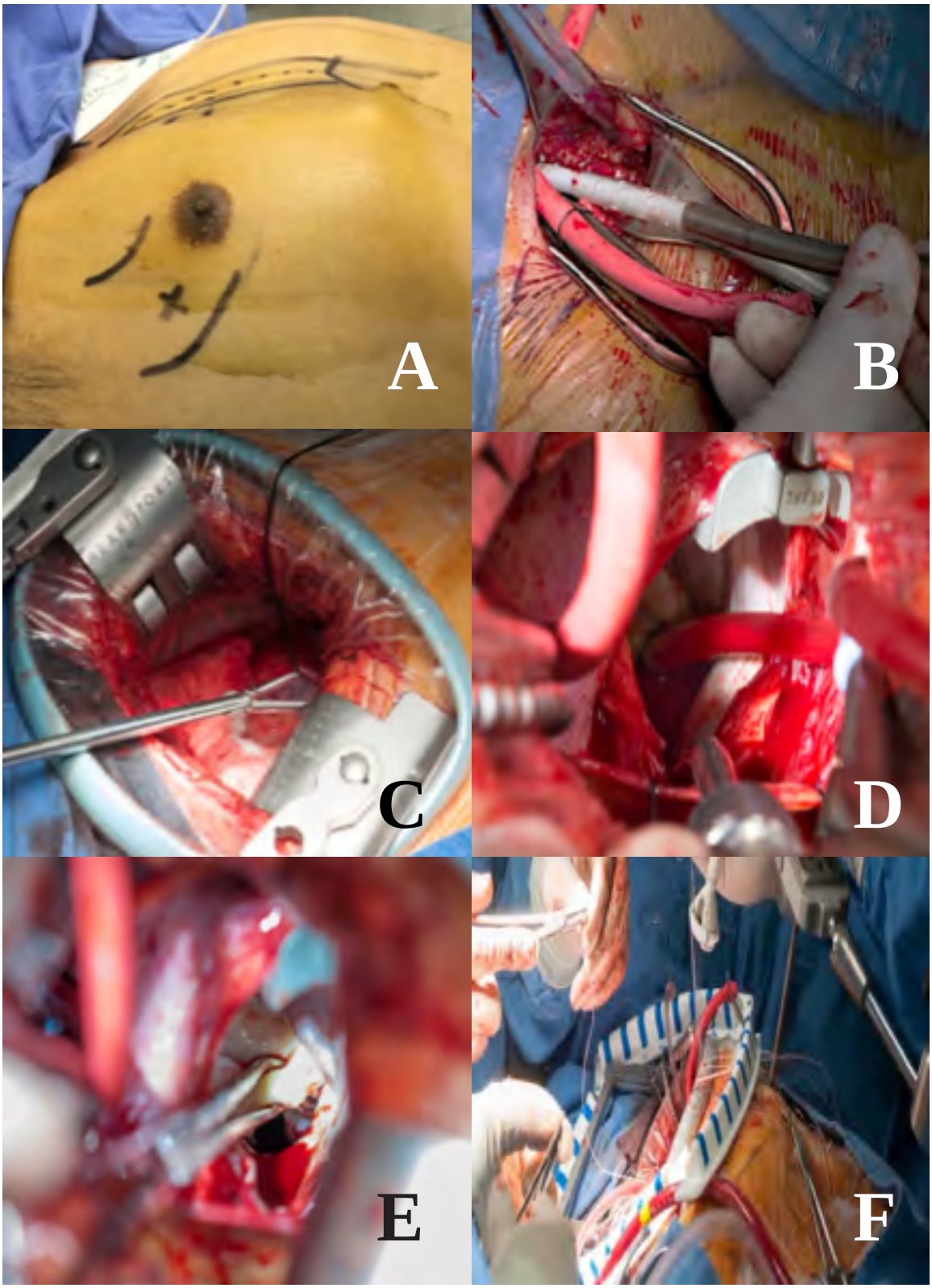

Figure 1.
A and B: Planning for right mini thoracotomy and arterial and venous femoral cannulation. C and D: Right mini thoracotomy and left atrial approach. E and F: Detail of manipulation of the anterior leaflet of the mitral valve and the mitral valve prosthesis implant .

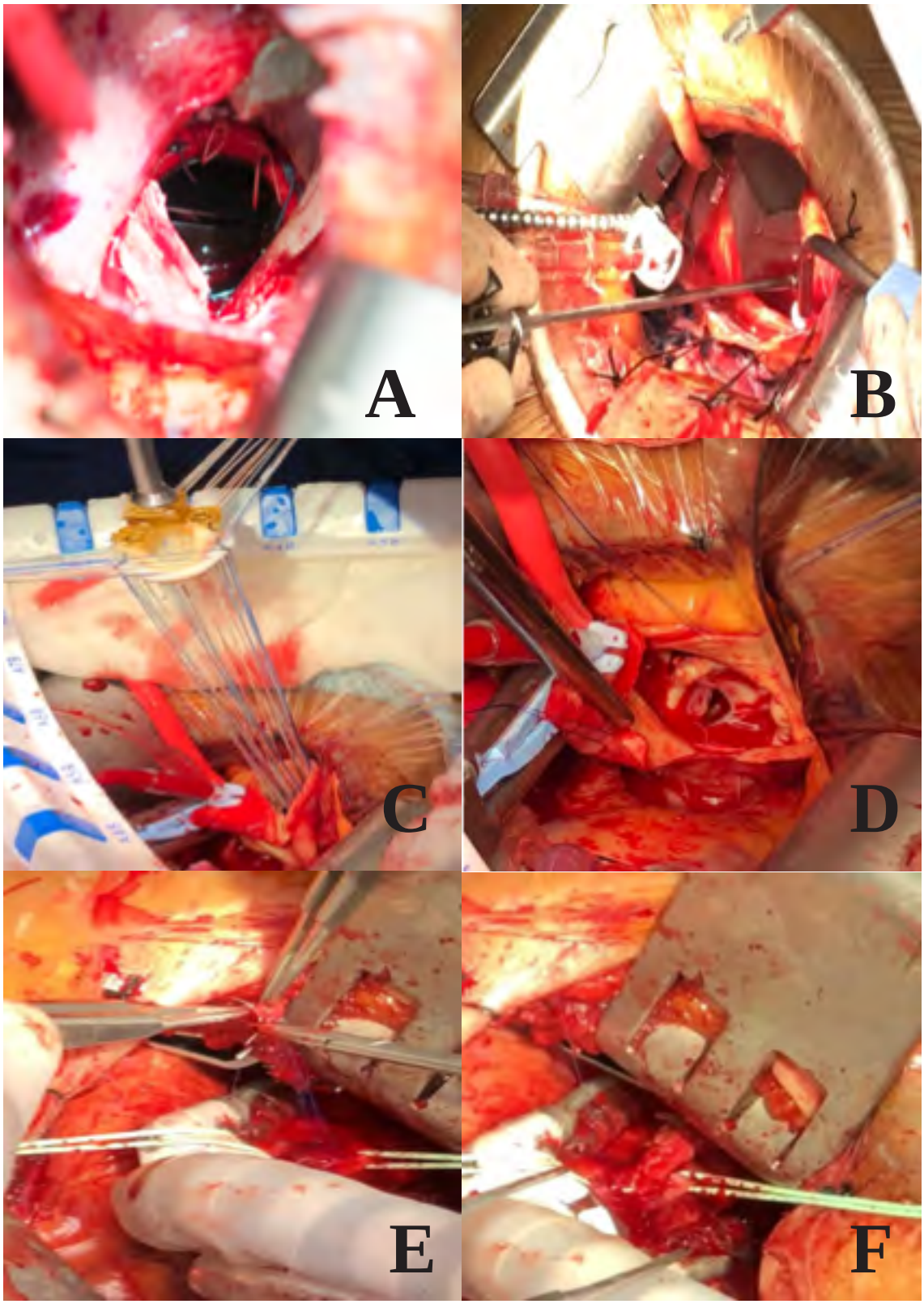

Figure 2. A and B. Detail of the approach for the mitral valve procedure through the left atrium with mechanical valve No. 27 or performance of Mitral plasty with mitral annulus No. 27. C and D. Detail of the aortic valve implant procedure with biological prosthesis No. 21, both by right mini thoracotomy.
E and F. Off-Pump Coronary Artery Bypass Grafting to the left internal mammary artery to the anterior descending by left mini thoracotomy.

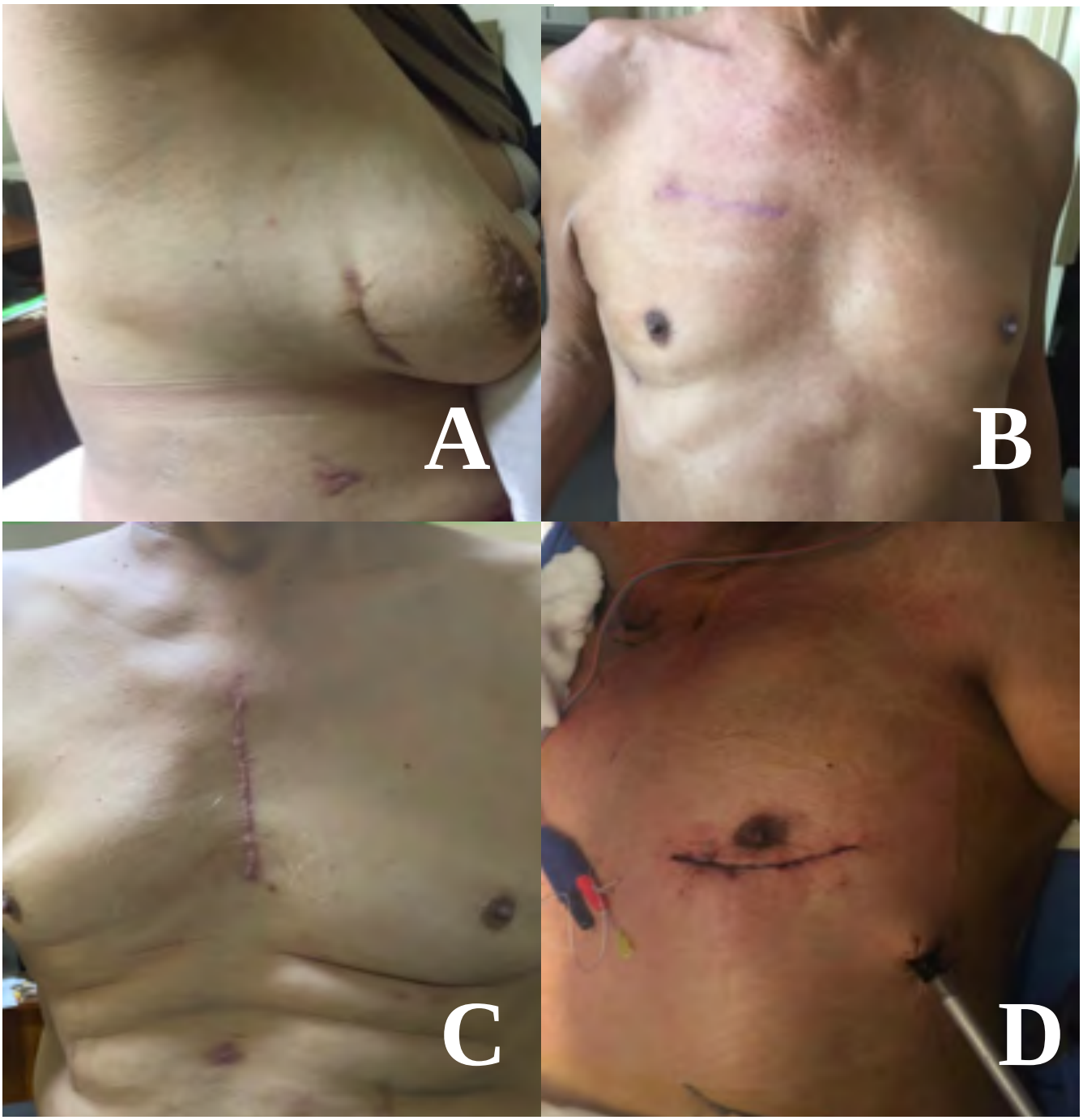

Figure 3. A. Right minthoratomomy for mitra valve, tricuspid valve or atrial septal defect approach. B. Right anterior minithoracotomy for aortic valve approach. C. Mini sternotomy for aortic valve approach. D. Left anterior minithoracotomy for off pump coronary artery bypass graft.

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