Systematic review of surgical procedures used in the treatment of aortic pathology in Mexico

Luis Barragán-Galindo, Alejandra Soto-Pérez, Javier E. Anaya-Ayala, Ramón García-Alva, César Cuen-Ojeda and Carlos A. Hinojosa*

Secretaría de Salud, Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán", Dirección de Cirugía, Sección de Angiología y Cirugía Vascular, Ciudad de México, Mexico

Abstract

Introduction: In Mexico, there are no appropriate statistical data on aortic disease, which can be treated with medical management or open or endovascular surgical approach. **Objective:** To carry out a systematic search and review of the literature in electronic databases with regard to invasive management of aortic pathology in Mexico. **Method:** A systematic search and narrative review of available literature was carried out using different electronic databases: PubMed, Imbiomed, Clinical Key, Bibliat, Scielo, Sage Journals and Science direct, as well as with the Google Scholar search engine. **Results:** Ninety articles were found, out of which only 53 met the inclusion criteria. Observational studies and case reports were selected, emphasizing on patient demographics, clinical results, and 30-day postoperative survival. **Conclusion:** An elevated rate of complications is reported for aortic pathologies due to underdiagnosis, which results in management being more complicated and prognosis unfavorable. The creation of a national aortic disease registry is crucial to standardization in the approach and optimization of outcomes.

KEY WORDS: Mexico. Aorta. Aneurysms. Coarctation. Trauma. Aortic dissection.

Introduction

Aortic diseases are part of the wide spectrum of arterial pathologies such as aortic aneurysms, pseudoaneurysm, aortic rupture, inflammatory conditions, genetic diseases and acute aortic syndromes.

In Mexico, currently there are no adequate statistics on aortic disease because it is underdiagnosed and causes of death are often attributed to other pathologies. Timely diagnosis is on the rise thanks to the new minimally-invasive diagnostic methods and the new deliberate search programs.¹

For treatment, medical management, or open or endovascular surgical approach are the possible options. Open surgery has been the treatment standard for various aortic pathologies with high morbidity and mortality. Although minimally-invasive procedures have gradually displaced open surgery, the latter remains necessary in some aortic pathologies and for the

management of complications that may arise from endovascular treatment.

Aortic aneurysm is defined as a focal dilation of the aorta that exceeds 50 % of its normal diameter and it results from progressive weakening of its walls; if it involves all three wall layers (tunica intima, tunica media and tunica adventitia) it is considered a true aneurysm; pseudoaneurysms are formed as a result of an injury in the aortic wall, where extraluminal blood flow remains in the surrounding tissue. Its most common location (90 %) is the abdominal aorta, specifically at its infrarenal portion. The most important risk factors include male gender, age older than 65 years, smoking, family history, hypertension and dyslipidemias. The most serious complication is aneurysm rupture, associated with a mortality rate of 80 %.

On the other hand, dissection is defined as the separation of aortic wall layers. Tears in the vessel intima can cause the dissection to expand, both proximally and distally, given that blood occupies the space

Correspondence:

*Carlos Hinojosa
E-mail: carlos.a.hinojosa@gmail.com

Date of reception: 24-05-2018
Date of acceptance: 24-11-2018
DOI: 10.24875/GMM.M19000245

Gac Med Mex. 2019;155:124-130
Contents available at PubMed
www.gacetamedicademexico.com

Figure 1. Flow-chart. Systematic search for literature on aortic pathology.

between the tunica intima and the tunica media. Despite technological advances in diagnostic and therapeutic methods, mortality associated with this pathology remains high. Aortic dissections are due both to genetic and environmental factors and their prevalence is higher in patients with connective tissue disorders, systemic hypertension, congenital aortic stenosis or bicuspid aortic valve.

Coarctation of the aorta is characterized by abnormal thickening of the tunica media and intimal hyperplasia. It accounts for up to 7 % of congenital heart diseases, with a prevalence of 0.2 per 1000 live births and a male-female ratio of 2:1. Often it affects the posterior wall at the origin of the subclavian artery, mainly the distal aortic arch and at the descending aorta root. Similarly, it is accompanied by cardiac anomalies, such as bicuspid aortic valve, patent ductus arteriosus or ventricular septum defects and is one of the anomalies commonly found in genetic syndromes, such as Turner's.²

Finally, vascular trauma has become a critical health problem. It can be encompassed mainly in traffic accidents or injuries generated by violence, which represent the leading causes of death in the young population.³ Aortic injury due to blunt trauma and deceleration is the second most common cause of death due to severe traffic accidents. Aortic rupture can

occur at any level of the thoracic aorta, although it is less common in the abdominal aorta.⁴ Timely diagnosis and treatment are essential for survival. Endovascular treatment is an excellent alternative because it reduces morbidity, mortality, surgical time and in-hospital stay.⁵

Method

A systematic search was carried out in the PubMed (www.ncbi.nlm.nih.gov/pubmed), Imbiomed (www.imbiomed.com.mx), Clinical Key (www.clinicalkey.com), Bibliat (www.bibliat.unam.mx/es/), Scielo (www.scielo.org), Sage Journals (www.journals.sagepub.com) and Science direct (www.sciencedirect.com) electronic databases and with the Google Scholar search engine. The terms "Mexico" and "aorta" were used as keywords.

Figure 1 outlines the systematic literature review process. Only articles published in Mexico were selected, with those related to aortic valve disease being excluded.

Results

In the 50 selected articles, 1383 patients were identified. The works were grouped according to the type of aortic pathology, and the statistics descriptive

analysis was classified into two groups: observational studies and case reports. The section “other aortic pathologies” was added, because not enough studies of some pathologies were found to perform individual analyses.

Aortic aneurism

Thirteen observational articles were reviewed, which included patients with thoracic and abdominal aortic aneurysm. Descriptive statistics was carried out, with standard deviations and means being determined. The results were weighted according to the number of patients per article (Table 1). Total number of patients included in the articles was 418, with a mean age of 64 years; 78 % of patients were males and 80 % were managed with open surgery; 30-day survival was 78 %.⁶⁻¹⁸

Case reports were also analyzed, divided according to the location of the aneurysm (Table 2).¹⁹⁻²⁹ Reports were found of five patients with aneurysms of the abdominal aorta, in whom average age was 70 years and 60 % were males; 60% were electively treated with the endovascular approach, with a 30-day survival of 80 %. Case reports were found of six patients with thoracic aorta aneurysms; mean age was 55 years and 83 % were males; 72 % were electively treated using the endovascular approach, with a 30-day survival of 83 %.

Figure 2A shows the three-dimensional reconstruction of an angiotomography of a patient with an aneurysm of the infrarenal aorta.

Coarctation of the aorta

Eight observational publications corresponding to coarctation of the aorta were found (Table 1).³⁰⁻³⁷ Seven hundred and sixty-one patients were quantified, with a mean age of 13 years, and with 70 % corresponding to the male gender. As for treatment, 58 % were operated using the endovascular approach. Mean transcoarctation gradient was specifically assessed in this pathology, both prior and after the intervention. Mean pressure gradient prior to treatment was 27 mmHg, whereas post-treatment it was 6 mmHg. Mean 30-day survival was 95 %.

For the descriptive statistics of case reports (Table 2),³⁸⁻⁴³ the same variables were used. Six reports were found, where average age was 17 years and 50 % of patients were males. Half of them received

endovascular treatment. As in the observational studies, the transcoarctation gradient was analyzed, with pre and post-treatment mean values of 69 mmHg and 8 mmHg, respectively, being found. No deaths were reported within the first 30 days after treatment.³⁸⁻⁴³

The open surgical procedure for coarctation of the aorta is shown in Figure 2B.

Other aortic pathologies

Observational studies and case reports of the following pathologies were analyzed: acute aortic syndromes, Takayasu arteritis, aortic dissections, congenital malformations, tumors with vascular involvement, aortic trauma and fistulas. They were grouped in the same category because of the paucity of works that have been published in Mexico on these subjects. The descriptive statistics of the most representative articles are detailed in Table 1.^{4,44-49}

The research that included the largest number of patients was conducted by Guering,⁴⁴ where the records of 94 patients with acute aortic syndromes (penetrating ulcers, intramural hematomas, complicated dissections and aortic transections) were reviewed. The endovascular approach was used in 67 % of patients, with a 30-day survival of 79 %.

The only article identified on aortic dissection included 10 patients with Marfan syndrome and type B dissections, who were openly intervened, with 30-day postoperative survival of 89 % (Figure 2C).⁴⁵

Two observational studies related to vascular trauma were found, which included four patients with a mean age of 34 years; two were males. All patients suffered closed trauma with involvement of the thoracic aorta; half of them underwent endovascular intervention. There were no deaths within the first 30 postoperative days.^{4,49}

In Hinojosa's work, two patients with Takayasu arteritis are referred to have developed middle aortic syndrome as a complication, which has a reported prevalence of 0.000001 % in patients with said pathology. The patients' mean age was 37 years, and both were females. They were approached with open surgery and 30-day survival was 100 %. Figure 2D shows a three-dimensional reconstruction of the angiotomography of one of the patients mentioned in the article.⁴⁶

Case reports were found on aortic fistulas, vascular trauma and congenital vascular pathologies (Table 2).^{5,50-55}

Table 1. Observational studies on invasive treatment of different aortic pathologies

Article number	Author	Patients (n)	Males (%)	Mean age (%)	Open approach (%)	30-day survival (%)
Aortic aneurism						
1	Rojas (1996) ⁶	31	90.30	64.7	100	76.90
2	Mendoza (2001) ⁷	20	75	67.8	100	100
3	Rojas (2002) ⁸	75	88	68.61	100	66
4	Ramírez (2004) ⁹	4	100	62.5	100	50
5	González (1996) ¹⁰	20	20	71	100	10
6	Álvarez (2002) ¹¹	101	74.20	69.1	100	72
7	Marquina (2008) ¹²	54	75.90	71.9	35.18	94.70
8	Serrano (2003) ¹³	6	33.30	41	100	100
9	Rodríguez (2011) ¹⁴	12	83.30	57.8	0	100
10	Fink (2002) ¹⁵	31	90.30	69.1	0	96.80
11	Ramírez (2003) ¹⁶	39	82.05	47	100	89.80
12	Careaga (2009) ¹⁷	2	100	11	100	100
13	Galicia (2010) ¹⁸	23	83	46	83	87
Total		418	77.99 %	64.6 ± 17.4	80.4	78.05
Coarctation of the aorta						
1	González (2006) ³⁰	7	85.70	24	0	100
2	Uruchurtu (1999) ³¹	6	83.30	27.1	0	100
3	Munayer (2002) ³²	272	73.50	8.1	0	98.50
4	Fink (2002) ³³	4	100	23.1	0	100
5	Hernández (2003) ³⁴	58	75.80	7	70	94.93
6	Márquez (2015) ³⁵	166	71	18	36.70	100
7	Zabal (2003) ³⁶	32	63	24.00	0	100
8	Cervantes (2006) ³⁷	216	61	13	100	86.20
Total		761	69.4	12.9 ± 7.9	41.72	95.16
Other aortic pathologies						
1	Espinoza (2013) ⁴	2	0	37.5	100	100
2	Guering (2015) ⁴⁴	94	74	50.9	33.00	78.80
3	Hinojosa (2015) ⁴⁶	2	0	37.5	100	100
4	Guering (2013) ⁴⁵	10	60	35.1	100	88.90
5	Mijangos (2015) ⁴⁷	5	60	5.6	100	80
6	Herrera (2011) ⁴⁸	3	100	28.5	100	66.60
7	Fink (2002) ⁴⁹	2	100	34	0	100

Mean age of the three patients reported with aortic fistulas was 66 years; 66 % were males. All were treated with open surgery. Two patients had cavaortic fistulas, one as a consequence of a retroperitoneal

intervention due to trauma and the other due to aneurysm of the abdominal aorta. There was one case of aortogastric fistula caused by an ulcer. Thirty-day survival was 100 %.

Table 2. Isolated case reports on invasive treatment of different aortic pathologies

Pathology	Reports (n)	Mean age	Males (%)	Open approach (%)	30-day survival (%)
Aneurysms of the abdominal aorta ¹⁹⁻²³	5	70	60	40	80
Aneurysms of the thoracic aorta ²⁴⁻²⁹	6	55	83.30	16.70	83.30
Coarctation of the aorta ³⁸⁻⁴³	6	17	50	50	100
Aortic fistulas ⁵⁰⁻⁵²	3	66	66	100	100
Vascular trauma ^{5,53,54}	3	26.33	0	33	100
Congenital aortic pathologies ⁵⁵	1	4	0	100	100

Figure 2. A) Aneurysm of the abdominal aorta in the infrarenal portion. B) Coarctation of the aorta repair intraoperative picture. C) Descending aorta dissection. D) Abdominal aorta stenosis in a patient with Takayasu arteritis (figure 2D taken from reference 46).

Three cases of vascular trauma were identified, all of the female gender. Mean age was 26 years. Two patients with injuries in the abdominal aorta were treated with the endovascular approach and one with injury in the thoracic aorta was treated with open surgery. No deaths were reported.

Finally, a case was reported of a four-year-old girl with a congenital vascular ring in the thoracic aorta who was treated with open surgery and whose postoperative evolution was favorable.

Discussion

Knowledge and timely diagnosis of aortic pathology in Mexico have increased in the past few years due to the implementation and gradual increase of screening programs at different institutes and health care centers around the country. However, it is necessary to generate broader and better programs aimed at

identifying a larger number of individuals at risk, in order to solve the population demand.

Even when aortic aneurysm continues to be the most common aortic pathology, we identified that a larger number of patients with coarctation of the aorta have been studied in Mexico; the patients included in this review account for 54.9 % of total patients, while patients with aortic aneurysms account for 30.15 %.

With regard to the surgical management of the analyzed aortic pathologies, 51.97 % of patients were treated with open surgery, and the rest was managed using an endovascular approach.

Although in our analysis only 30-day postoperative survival was taken into account, postsurgical complications are mentioned in some of the included studies. In the group of patients treated with open surgery, renal vein injury, retroperitoneal hematoma, acute kidney injury, respiratory failure and ischemic stroke are referred. On the other hand, in the group of endovascular approach, the most common complications were vascular perforation, ischemic stroke and thrombosis at the entry point.

The 30-day mortality rate of patients undergoing surgery was 12.33 %. The pathology with the highest rate was aortic aneurysm, with 21.8 %.

Owing to its high population density and the coverage shortage in the systems for early detection and timely treatment, it is expected that a significant percentage of these aortic pathologies will continue to be underestimated and underdiagnosed in Mexico.

Conclusion

Aortic pathology remains an important cause of morbidity and mortality in Mexico, and the training of more specialists with adequate surgical skills on these pathologies and their complications is therefore necessary.

Moreover, we consider that the training of doctors who are not specialists in angiology and vascular surgery on the knowledge and diagnosis of aortic pathologies would be highly useful for the detection of the disease at early stages.

As for the field of clinical research, aortic pathology represents an area of opportunity in Mexico. We consider that the creation of a national registry of aortic disease would be relevant to the optimization of clinical results. For this reason, we can conclude that promoting the growth of research would be essential, in order to integrate an accurate knowledge of these pathologies and this way offer the most opportune treatment for each one of them.

References

- Martínez-Hernández H. Los aneurismas de la aorta torácica y su enfoque terapéutico. *Arch Cardiol Mex*. 2006;76:S124-S133.
- Márquez-González H, De León Mena S, Yáñez-Gutiérrez L, López-Gallegos D, Camargo-Zetina CO, Ortiz-Vázquez IC, et al. Complicaciones tardías de tratamiento de coartación aórtica: estudio mexicano de cohorte con más de 10 años de seguimiento. *Rev Mex Cardiol*. 2015;26:169-173.
- Castañeda-Gaxiola, R. El problema del trauma vascular en México. *Cir Gen*. 2000;22:254-256.
- Espinoza HJD, Nina VO, Venegas GU, Marroquín RR, Villarreal RCB, Molina E. Ruptura traumática de aorta torácica. Reporte de dos casos. *Rev Latinoam Cir*. 2013;3:47-50.
- Kalach-Mussali AJ, Montes-Corales BS, Vázquez-Minero JC. Diagnóstico oportuno de la disección de aorta por traumatismo contuso. *Neumol Cir Torax*. 2013;72:223-228.
- Rojas, GA, Cervantes, J, Arcos, L, Guibovich, V, Colin, V. Aneurismas de la aorta abdominal. Cinco años de experiencia en el hospital American British Cowdray. *Rev Mex Angiol*. 1996;24:34-39.
- Mendoza-Cortés A, Rodríguez-Trejo JM, Escotto-Sánchez I, Flores-Padilla CM, Montuy-Vidal MA, Sulvarán-Aguilar A, et al. Abordaje retroperitoneal en aneurismas de aorta abdominal. *Rev Mex Angiol*. 2001;29:5-14.
- Rojas GA, Cervantes J, Torrontegui Á. Análisis de resultados en cirugía de aneurismas de aorta abdominal. Experiencia de 32 años. *Rev Mex Angiol*. 2002;30:38-42.
- Ramírez-González AH, Corona-Murguía A, Murillo-Estrada D, Moreno-López M, Pérez-Villagómez Y, Tinoco-Pérez S, et al. Aneurisma roto de aorta abdominal. Experiencia en Uruapan Michoacán. *Rev Mex Angiol*. 2004;32:126-131.
- González LG, Sánchez C, Martínez CM. Aneurismas de aorta abdominal rotos: dos años de experiencia. *Rev Mex Angiol*. 1996;24:55-58.
- Álvarez Tostado-Fernández F, Martínez Hernández-Magro P, Villanueva-Sáenz E. Colitis isquémica en pacientes sometidos a cirugía de reemplazo aórtico. Factores de riesgo. *Rev Gastroenterol Mex*. 2002;67:171-178.
- Marquina ME, Rodríguez TJM, Escotto SI, Rodríguez N, Morales GLG, Espinosa APA. Complicaciones en el tratamiento de aneurisma de aorta abdominal infrarrenal del adulto mayor. *Rev Mex Angiol*. 2008;36:126-134.
- Serrano CA, Martínez C, Sánchez B, García J, Vera O, Jiménez J. Experiencia quirúrgica con los aneurismas de aorta abdominal en el síndrome de Marfan. *Rev Mex Angiol*. 2003;31:13-17.
- Rodríguez-Ortega F, Hernández-Mercado MA, Reyes-Corona JA, Gómez-Ríos N, Jaymes-Núñez A, Alegría-Gardía H, et al. Tratamiento endovascular del aneurisma de aorta abdominal. *Cir Gen*. 2011;33:43-47.
- Fink JG, Gutiérrez VS, Dena EE, Hurtado LLM, Zaldivar RFR. Tratamiento endovascular del aneurisma de aorta abdominal en pacientes mayores a 60 años: morbimortalidad perioperatoria. *Cir Gen*. 2002;24:34-39.
- Ramírez-Vargas AF, Careaga-Reyna G, Téllez-Luna S, Argüero-Sánchez R. Tratamiento quirúrgico de los aneurismas de la aorta torácica. *Rev Mex Cardiol*. 2003;14:118-127.
- Careaga-Reyna G, Ramírez-Vargas AF, Martínez Hernández-Magro R, Argüero-Sánchez R. Aneurisma de la aorta torácica en coartación aórtica sin cirugía previa. Presentación de dos casos. *Cir Ciruj*. 2009;77:61-63.
- Galicia-Tornell MM, Marín-Solís B, Fuentes-Orozco C, Martínez-Martínez M, Villalpando-Mendoza E, Ramírez-Orozco F. Procedimiento de Bentall en la enfermedad aneurismática de la aorta ascendente: mortalidad hospitalaria. *Cir Cir*. 2010;78:45-51.
- Soto-Hernández G, Alvarado-Lezama J, Bizueto-Rosas H, Madrid-Mier E, Martínez-Maya H, Mejía-Valero SA. Síndrome aortoduodenal secundario a un aneurisma de la aorta abdominal roto contenido. *Rev Mex Angiol*. 2014;42:95-101.
- Morales-Victorino N, García-López S, Alcántara-Meléndez MA, Herrera-Gomar M, Guering-Eid L, González-Chon O. Reparación endovascular de aneurisma abdominal. *Rev Invest Med Sur Mex*. 2011;18:179-182.
- Lacayo M, Lecuona N, Córdova P, Flores, S, Cárdenas, Á. Tratamiento endovascular de Aneurisma de Aorta abdominal en el Hospital General de México. *Rev Med Hosp Gen Mex*. 2016;79:161-164.
- Candia-De la-Rosa RF, Córdova-González I, Rodríguez-Esqueda M, Rico-Olvera H. Aneurisma infrarrenal de la aorta abdominal. Reporte de un caso. *Rev Sanid Milit Mex*. 2003;57:173-179.
- Gutiérrez-Carreño AR, Lizola-Margolis RI, Mendieta-Hernández M. Aneurisma de aorta abdominal micótico roto. Manejo híbrido. *Rev Mex Angiol*. 2017;45:139-142.
- Alcántara PA, Cogordan CJ, Reyes BC, Gómez CA, Huerta HD. Tratamiento no quirúrgico del aneurisma disecante de la aorta torácica mediante colocación de implante endovascular. Informe de un caso. *Rev Sanid Milit Mex*. 2000;54:214-216.
- Mendoza-Álvarez SA, Fuentes-León J, Vargas-Ayala G, Hernández-González C, López-Arias G, Vera-Lastra O. Síndrome de Marfan, aneurisma toracoabdominal disecado y embarazo. Informe de un caso. *Rev Med Inst Mex Seguro Soc*. 2009;47:669-672.
- Cohen-Mussali S, Zerrweck-López C, Rey-Rodríguez A, Valdés-Flores JA, Vidal-González P, Ramírez-Cerda C. Puente carótido-subclavio y prótesis endovascular como manejo híbrido de aneurisma de aorta torácica. *An Med Mex*. 2013;58:55-59.
- Díaz-Quiroz G, Archundia-García A, Vázquez-Minero JC, Aceves-Chimal JL. Manejo quirúrgico de aneurisma de aorta ascendente. Presentación de un caso. *Rev Esp Med Quir*. 2003;8:52-55.
- Martínez-Tapia AL, Robles-Pérez E, Jiménez-Hernández A, Ramos-Cano VH. Aneurisma disecante de aorta ascendente. A propósito de un caso y revisión de la literatura. *Rev Hosp Jua Mex*. 2014;81:60-67.
- Herrera-Gomar M, Alcántara-Meléndez MA, Lomeli-Estrada C, Mendoza-González C, Aguirre-Molina CA, Lorenzo-Negrete JA, et al. Aneurisma de aorta torácica por úlcera aterosclerótica penetrante: tratamiento endovascular, híbrido o cirugía. Revisión. *Arch Cardiol Mex*. 2009;79:140-146.
- González-Álvarez CJ, Ordóñez-Toquero G, Rivera-Quintero E. Angioplastia con stent en el tratamiento de coartaciones aórticas críticas. *Arch Cardiol Mex*. 2006;76:424-430.
- Uruchurtu E, Sánchez A, Pavia A, Hernández I, Valle L, Esquivel M, Medel O, Vargas C. Aortoplastia en coartación aórtica congénita del adulto con balón y prótesis endovascular: resultados inmediatos y seguimiento a 6 meses. *Arch Cardiol Mex*. 2000;70:72-77.
- Munayer-Calderón J, Zabal-Cerdeira C, Ledesma-Velazco M, Aldana-Pérez T, Ramírez-Reyes H, Lázaro-Castillo JL. Balloon angioplasty in aortic coarctation: a multicentric study in Mexico. *Arch Cardiol Mex*. 2002;72:20-28.
- Fink, G, Gutiérrez VS, Hurtado LLM. Cirugía endovascular mediante el implante de endoprótesis Talent en pacientes adultos con coartación de la aorta torácica: experiencia inicial de cuatro pacientes. *Cir Gen*. 2002;24:232-236.
- Hernández-González M, Solorio S, Conde-Carmona I, Rangel-Abundis A, Ledesma M, Munayer J, et al. Intraluminal aortoplasty vs. surgical aortic resection in congenital aortic coarctation. A clinical random study in pediatric patients. *Arch Med Res*. 2003;34:305-310.
- Márquez-González H, De León-Mena S, Yáñez-Gutiérrez L, López-Gallegos D, Camargo-Zetina CO, Ortiz-Vázquez IC, et al. Late complications of aortic coarctation treatment: a Mexican cohort study with more than 10-year follow up. *Rev Mex Cardiol*. 2015;26:169-173.
- Zabal C, Attie F, Rosas M, Buendía-Hernández A, García-Montes JA. The adult patient with native coarctation of the aorta: balloon angioplasty or primary stenting? *Heart*. 2003;89:77-83.
- Cervantes-Salazar JL, Ramírez-Marroquín S, Benita-Bordes A, Rosas-Peralta M, Attie F. Tratamiento quirúrgico de la coartación de aorta. Resultados a largo plazo en el Instituto Nacional de Cardiología. *Arch Cardiol Mex*. 2006;76:63-68.
- Buenfil-Medina JC, Jiménez-Carbajal MG, Santiago-Herrera R, Fernández-Luna CP. Stent BeGraft Bentley® para tratamiento de coartación aórtica. *Arch Cardiol Mex*. 2018;88:313-315.
- Maltos-Valdés W, Cáceres-Papadakis GU, Garza-Alatorre AG, Rodríguez-Balderrama I. Miocardiopatía dilatada secundaria a coartación de la aorta. *Rev Mex Pediatr*. 2004;71:25-27.
- Rojas DMA, García MA. ¿Es la angioplastia el tratamiento de elección en la coartación de aorta? Presentación de un caso clínico y revisión de la literatura. *Med Int Mex*. 2010;25:524-529.
- Rosas MA, Bolio A, Reyes NI, Sienra J. Coartación de la aorta y sibilancias. *Bol Med Hosp Infant Mex*. 1997;54:241-243.
- Reyna-Cuevas VM, Segura-Vera L, Borbolla-Sala ME. Angioplastia con stent en coartación aórtica severa, con abordaje por arteria humeral. *Salud Tab*. 2013;19:66-70.
- Parra-Bravo JR, Acosta-Valdez JL, Zepeda-Sanabria JR, Beirana-Palencia LG, Rodríguez-Hernández L, Estrada-Loza MJ, et al. Agnesia unilateral de una arteria pulmonar y coartación de aorta en un paciente con síndrome de Turner. *Rev Mex Cardiol*. 2002;13:162-170.

44. Guering, EL, Gaspar-Hernández J, González-Pacheco H, Acevedo-Gómez P, Ramírez-Marroquín S, Herrera-Alarcón V, et al. Complicated acute aortic syndromes affecting the descending thoracic aorta: endovascular treatment compared with open repair. *Clin Cardiol*. 2015;38:585-589.
45. Guering, EL, Gaspar, J, Meléndez-Ramírez, G, Cervantes, J, González-Pacheco, H., Dámas de los Santos, F, et al. Endovascular treatment of type B dissection in patients with Marfan syndrome: mid-term outcomes and aortic remodeling. *Catheter Cardiovasc Interv*. 2013; 82:E898-E905.
46. Hinojosa CA, Anaya-Ayala JE, Torres-Machorro A, Lizola R, Laparra-Escareno H. Middle aortic syndrome in Takayasu's arteritis: report of two surgical cases. *Ann Vasc Surg*. 2015;34:e13-e17.
47. Mijangos-Vázquez R, Miranda-Chávez IO, Soto-López ME, Patiño-Bahena EJ, Cano-Zárate R, Covarrubias-Flores AC, et al. Anomalous origin of pulmonary branches from the ascending aorta. A report of five cases and review of the literature. *J Cardiol Cases*. 2015;11:1-6.
48. Herrera-Gómez Á, Ortega-Gutiérrez C, Luna-Ortiz K, De-León-Zaragoza L. Resección arterial de grandes vasos debido a tumor germinal residual retroperitoneal. Tres casos. *Cir Gen*. 2011;33:127-131.
49. Fink JG, Fernández SE, Gutiérrez VS, Hurtado LLM, Ruiz DA. Manejo endovascular de la transección de aorta torácica por trauma cerrado de aorta: informe de dos pacientes. *Cir Gen*. 2002;24:144-147.
50. Sigler-Morales L, Martínez-López C, González-Valenzuela J, Guevara-Saldivar MI, Jaramillo-Talavera J. Fístula aortocava y embolia por proyectil de arma de fuego a la arteria poplítea. *Cir Cir*. 1997;65: 56-58.
51. Delgadillo GH, Velásquez JA, Fening J, Campos F, Cervantes J, Medina B. Fístula aorto-gástrica. Informe de un caso tratado con reparación de la aorta, gastrectomía total y esófago-yeyuno-anastomosis en Y de Roux. *Cir Gen*. 2003;25:234-237.
52. Rocha-Rodríguez MG, Rodríguez-Blas AI, Balcázar-Vázquez R, Casian-Castellanos GA, Flores-Cabos AE. Fístula aorto cava asociada con aneurisma de aorta abdominal: reporte de un caso. *Rev Hosp Jua Mex*. 2010;77:133-137.
53. Vidal-González P, Mussan-Chelminsky G, Kunz-Martínez W, Jonguitud-Bulos V, Rey-Rodríguez A, Cohen-Mussali S. Tratamiento endoluminal para ruptura aórtica por trauma. Reporte de un caso y revisión de la literatura. *Cir Cir*. 2007;75:297-302.
54. Gamboa R, Ríos-Méndez RE, Solernó R, Giachello F, Videla-Lynch A, Sarmiento RA. Exclusión percutánea de pseudoaneurisma aórtico abdominal traumático desde acceso braquial. *Arch Cardiol Mex*. 2011;82:34-36.
55. López RJA, Parada LJR, Sagahón MJA, Corona PMA, Aguilar AE, Gómez ML, et al. Reparación quirúrgica de doble arco aórtico. *Rev Esp Med Quir*. 2012;17:210-213.