

# The First Aortic Endoaneurysmorrhaphy

Ricardo Lozano Monzón (1872–1934)

Francisco S. Lozano-Sanchez, MD, PhD,\*†‡ and M. Begoña García-Cenador, PhD†‡

**Abstract:** In 1888, Rudolph Matas described and performed a procedure (endoaneurysmorrhaphy) that revolutionized the treatment of aneurysms, which for centuries had been untreatable or simply involved treatment by ligation and other marginal techniques. In 1940, during the annual meeting of the *American Surgical Association*, Matas presented the excellent results he had obtained with 98 endoaneurysmorrhaphies, although none of these cases involved an aortic aneurysm. On November 4, 1904, a Spanish surgeon called Ricardo Lozano Monzón was the first person in the world to perform an endoaneurysmorrhaphy on a patient suffering from an abdominal aortic aneurysm. The case was reported in a local journal called *La Clínica Moderna* in 1905. Despite the journal's limited circulation, Matas and others acknowledged that Lozano was the practitioner of the first, although admittedly unsuccessful, endoaneurysmorrhaphy on an abdominal aorta. Lozano's attempt was followed by other equally unsuccessful ones until Isaac A. Bigger performed the first successful procedure in 1938. The different kinds of endoaneurysmorrhaphy that Matas used, which proved to be effective in the treatment of peripheral aneurysms, did not perform in the same way in aortic aneurysms. Nonetheless, the procedure paved the way for new ideas and contributions (Crech technique).

**Keywords:** endoaneurysmorrhaphy, Matas procedure, aneurysms, abdominal aortic aneurysms

## INTRODUCTION

While dissecting a cadaver in 1554, the anatomist Andreas Vesalius became the first person to diagnose an abdominal aortic aneurysm (AAA). Almost 3 centuries would subsequently pass until the first therapeutic attempts were made to treat this complaint.

The first therapeutic steps involving AAAs used a ligature, as with peripheral aneurysms. In terms of the aorta, the pioneer was Astley Paston Cooper (1817), who performed an unsuccessful ligation for an iliac artery aneurysm; this technique was subsequently championed by, among others, William Stewart Halsted (1910), who used metal bands. Nonetheless, the first successful case of the ligature of the aorta to treat an AAA did not come until 1923; the patient operated on by Rudolph Matas survived for 17 months, dying of pulmonary tuberculosis.<sup>1</sup> This

technique, involving a ligature on the aorta, did not record good results, but there were no other options.

In 1864, a second therapeutic technique was used when Charles Moore inserted a cable into the sac of the aneurysm for introducing wires to thrombose the aneurysm (wiring technique). In 1879, Alfonso Corradi connected Moore's cable to a power supply (battery) with a view to speeding up the thrombosis. The results were not satisfactory on this occasion either. In 1900, Matas reported his unsuccessful attempts to treat his patients with an AAA using the Moore-Corradi technique.<sup>2</sup>

The next stage in the treatment of AAAs was launched by Rudolph Matas, with his concept of "endoaneurysmorrhaphy" (1888).<sup>3</sup> This constituted a major step forward in their treatment, especially of peripheral ones. In contrast to ligatures, 2 of the variants of endoaneurysmorrhaphy do not interrupt the blood flow (Figure 1). Nevertheless, the treatment of AAAs continued to be largely palliative for many more years until the contribution made by Charles Dubost (1951) involving the resection of the aneurysm and its replacement by a homograft.

This article seeks to describe the first historical cases of aortic endoaneurysmorrhaphy for treating an AAA, focusing on the first surgeon to perform this procedure.

## FIRST AORTIC ENDOANEURYSMORRHAPHY

In 1940, Rudolph Matas (New Orleans, Louisiana) acknowledged Ricardo Lozano as the first to perform, albeit unsuccessfully, an endoaneurysmorrhaphy on an AAA. While discussing Daniel C. Elkin's presentation at the American Surgical Association,<sup>4</sup> Matas stated: "We have records of five endoaneurysmorrhaphies for abdominal aortic aneurysms (Ricardo Lozano Monzón, 1905; John C. Munro, 1906; George W. Crile, 1907; John H. Gibbon, 1912), all of which ended fatally, except the last operation performed by Doctor Bigger, January 10, 1939." Matas goes on to say, "Doctor Bigger's operation is also of special interest to me as it is the first successful application to the aorta of my method of intrasaccular suture (endoaneurysmorrhaphy) for the cure of aneurysm." Finally, Matas stresses that "All of these operations were performed under desperate and seemingly hopeless circumstances for

From the \*Department of Vascular Surgery, University Hospital of Salamanca, Salamanca, Spain; †Department of Surgery, University of Salamanca (USAL), Avenida Alfonso X "El Sabio" s/n, Salamanca, Spain; and ‡Institute for Biomedical Research of Salamanca (IBSAL), Hospital Virgen de la Vega, Salamanca, Spain.

The authors declare no conflicts of interest. F.S.L., one of this article's authors, and Ricardo Lozano Monzón share the same family name, but they are not related in any way.

F.S.L.-S. did concept and design, analysis and interpretation, data collection, drafting, critical revision, and final approval. M.B.G.-C. did data collection, critical revision, and final approval.

Reprints: M. Begoña García-Cenador, PhD, Department of Surgery, University of Salamanca (USAL), Avenida Alfonso X "El Sabio" s/n, 37007 Salamanca, Spain. Email: mbgc@usal.es.

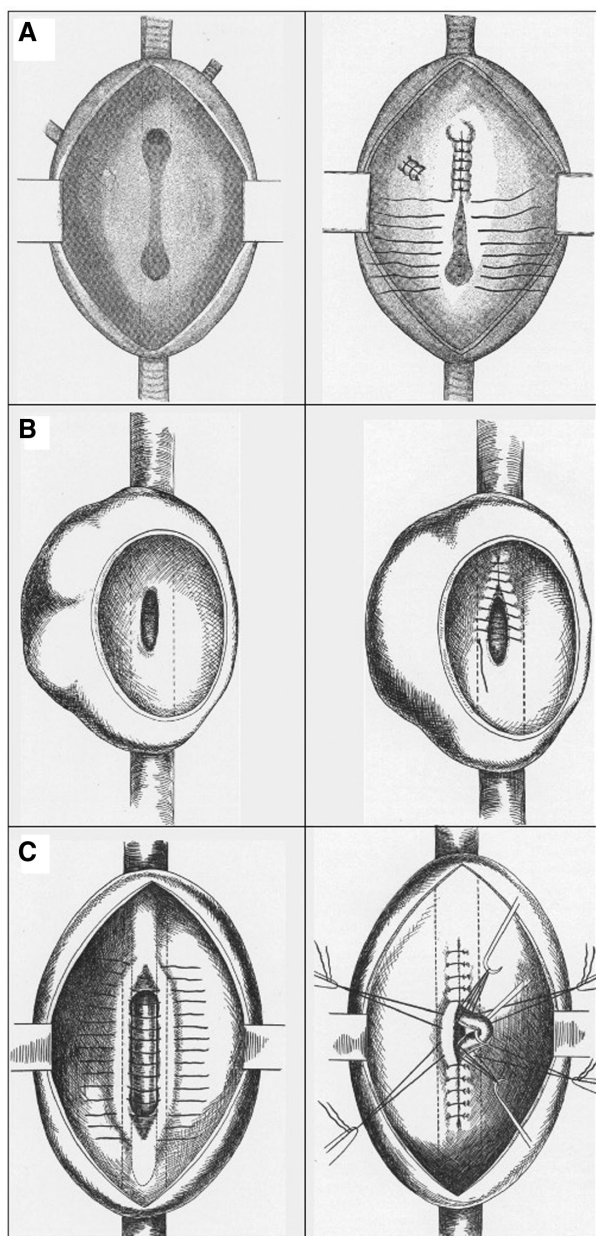
Copyright © 2021 The Author(s). Published by Wolters Kluwer Health, Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

*Annals of Surgery Open* (2021) 3:e086

Received: 14 January 2021; Accepted 9 July 2021

Published online 12 August 2021

DOI: 10.1097/AS9.000000000000086



**FIGURE 1.** Endoaneurysmorrhaphy according to Matas (Ann Surg 1903;37:161–196). A, Obliterative type (upper part of the figure): Opening of the aneurysm, exposure of the arterial orifices, and closure of the orifices through suturing. B, Restorative type involving a sacciform aneurysm (middle part): Opening of the aneurysm to expose the communication with the artery and closure of the orifice with continuous suturing or several stitches. C, Reconstructive type on a fusiform aneurysm (lower part): opening of the aneurysm to expose the communication with the artery; this orifice is closed with continuous suturing. To avoid the narrowing of the arterial gap, a segment of rubber tube is used as a guide for applying the suture. The closure of the aneurysmatic sac is the final and common step in the 3 types of endoaneurysmorrhaphy.

ruptured or leaking sacs, 2 dying on the table and the 2 others surviving only a few hours.”

In 1907, Dr Munro (Boston, Massachusetts), who performed the second-ever aortic aneurysmorrhaphy, ended his article<sup>5</sup> by recognizing Lozano’s primacy when he says, “Note.- Since reading this paper, I see that Lozano, of Saragosa, has attempted to close by internal suture an aneurysm of the bifurcation of the aorta. The sutures controlled the hemorrhage from the sac, but fatal hemorrhage took place from the proximal portion of the aorta. He operated in November, 1905” (it was in fact 1904).

In an article describing his successful case,<sup>6</sup> Dr Bigger (Richmond, Virginia) affirmed: “Aneurysmorrhaphy for the cure of aneurysm of the abdominal aorta has been attempted by Ricardo Lozano Monzón, John C. Munro, George W. Crile, Hermann Kümmel, and Isaac A. Bigger (traumatic). All of the patients so operated upon, except the one reported in this paper, died. A report of Crile’s case has not been available for study, but a review of Munro’s, Kummel’s, and Lozano’s reports brings out certain points in the technic employed in each of these operations, which may be significant in relation to the outcome.”

When referring to the contribution made by Lozano’s technique, he says: “Lozano applied clamps (without rubber coverings) to the very sclerotic aorta above and below the aneurysm before opening the sac. He then closed the arterial openings in the sac by suture and obliterated it. This part of the operation was apparently successfully accomplished, but when the obstructing clamps were removed, there was bleeding where the sclerotic vessel wall had given way beneath them. It is possible that, with such advanced sclerosis, any form of compression would have produced the same result, but unprotected clamps would be particularly likely to cut through such a vessel wall.”

### RICARDO LOZANO MONZÓN (1872–1934)

Ricardo Lozano was born in Daroca (Zaragoza, Spain) on 27 June 1872. He died in the city of Zaragoza on November 18, 1934. He was a surgeon, a university professor, and a pioneer in various fields of surgery.<sup>7,8</sup>

He studied medicine at Zaragoza University, where he spent almost his entire professional and scientific career. In 1899, he was awarded the Chair in Anatomy and a few months later the Chair in Surgery in the Faculty of Medicine at Zaragoza University, a post he held until his death. He was the dean at the Faculty of Medicine between 1928 and 1932.

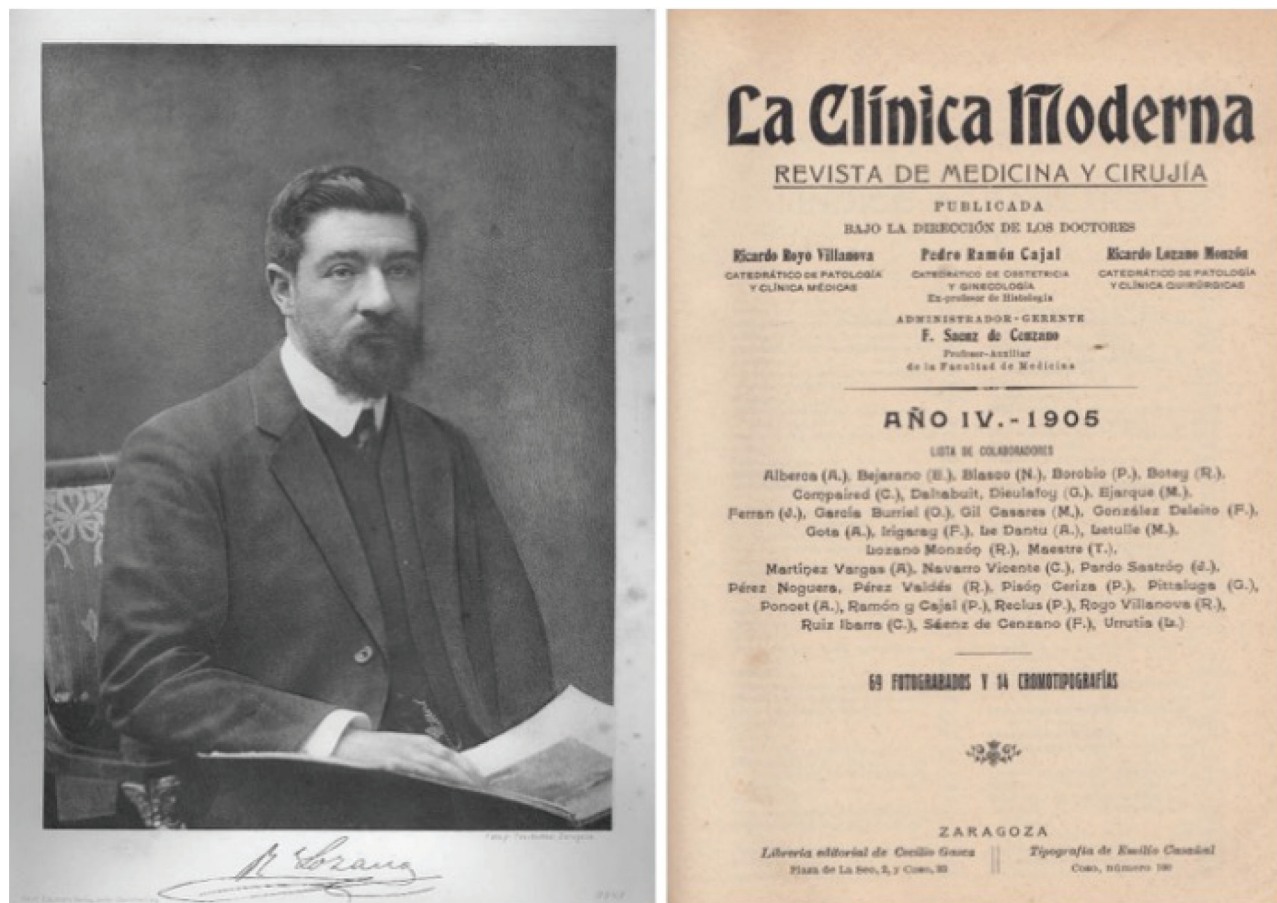
An inveterate traveler, he visited hospitals in France, Germany, and the United Kingdom, meeting Ernst von Bergmann, Albert Hoffa, and Rickman Godlee, among others. This provided him with an opportunity to observe that the latest surgery at that time was based on scientific grounds and a hospital infrastructure that were still unknown in Spain. His contacts with these outstanding surgeons enabled him to introduce Spain to some of the major advances in surgery toward the end of the 19th century and become the Spanish surgeon of his generation with the greatest international influence.

He was a general surgeon who pioneered many of today’s specialties: vascular surgery, plastic surgery, neurosurgery, and mainly thoracic surgery. At the same time, he introduced local anesthesia to Spain.

On November 4, 1904, he performed an endoaneurysmorrhaphy at the Faculty of Medicine in Zaragoza on a 53-year-old man, a coalman by trade, with an AAA. The case was reported in a local journal (Figure 2).<sup>9</sup>

Besides vascular surgery, Lozano introduced thoracic surgery to Spain at a time when only a handful of clinics in Europe were performing it. In Zaragoza, therapeutic pneumothorax had been performed since 1907, years before it was introduced in France and the United Kingdom. Concerning hydatidosis, an endemic disease in his home region of Aragón, he conducted epidemiological, clinical and therapeutic studies, and for the first time in the world, he treated hydatid cysts in the lung in a single surgical procedure, using instruments that he had designed himself. He shared the position of the world’s leading exponent in this field with Devé, from Rouen.

These and other activities enabled him to forge close ties with Europe’s leading surgeons at the time (Ernst Ferdinand Sauerbruch, Hans von Haberer, Erich Lexer, Jean Louis Faure, Grey Turner, and Victor Pauchet), who from 1920 onward paid frequent visits to Zaragoza to give lectures, take part in courses, and perform surgical operations.



**FIGURE 2.** Ricardo Lozano Monzón (Zaragoza, Spain) in 1908. Cover of the journal *La Clínica Moderna* (1905), which published the world's first case of endoaneurysmorrhaphy involving an abdominal aortic aneurysm.

Lozano's international recognition led to invitations to lecture at the Faculty of Medicine in Paris and operate at hospitals there on numerous occasions, as well as at the Ludwig Maximilian University in Munich, one of surgery's meccas, where he was appointed Ehrenbürger (Honorary Professor) in 1921. This same university offered him the position of Chair, an unprecedented step in Germany in the case of a foreign national. Lozano declined the offer because he believed he could make Zaragoza a global center for the furtherance of surgery, as he had seen in the small city of Bern at the beginning of the century, attracting surgeons from all over the world, drawn by Professor Kocher's work.

He created a leading school of surgery. His scientific output consists of more than 120 scholarly articles in journals both at home in Spain and abroad, and 20 books, such as the one devoted to aortic abdominal surgery.<sup>10</sup> Further highlights are the 3 volumes on Surgical Pathology, published between 1920 and 1926, in collaboration with Otto Chiari, Ernst Ferdinand Sauerbruch, and Nicolai Guleke, among others. In 1904, together with Pedro Ramón y Cajal and Ricardo Royo Villanova, he founded the journal "La Clínica Moderna."

His other appointments and accolades included his membership of the Royal Academy of Medicine in Zaragoza (1903), honorary member of the Surgery Society in Madrid (1904), the Red Cross's gold medal in Zaragoza (1904), and the German Red Cross's silver medal (1904). In 1923, he was made an honorary member of Munich's Maximilian Universität.

## DISCUSSION

Rudolph Matas (1860–1957) invented and successfully performed the first endoaneurysmorrhaphy. This revolutionary

procedure earned him a place in surgical history, and William Osler called him the "father of vascular surgery."<sup>11</sup>

Concerning this first-ever endoaneurysmorrhaphy, performed on May 6, 1888, at the Charity Hospital in New Orleans (Louisiana),<sup>3</sup> note should be taken of the following: (a) terminologically speaking, the aneurysm treated was in fact a brachial artery pseudoaneurysm of traumatic origin, and (b) this endoaneurysmorrhaphy is not the same as the first "aortic" endoaneurysmorrhaphy.

In 1903, Matas published a detailed study on the treatment of aneurysms in which he distinguished between an "obliterative endoaneurysmorrhaphy" (procedure performed in 1888) and "restorative and reconstructive endoaneurysmorrhaphy," in which the arterial blood flow is maintained<sup>12</sup> (see Figure 1).

Rudolph Matas recounted his experience (1888–1940) in the treatment of aneurysms to the *American Surgical Association* (St. Louis, May 1–3, 1940), providing a high number of cases for the time of 620 aneurysms in diverse locations, with a mortality rate of 4.83%. His case history covered 98 endoaneurysmorrhaphies (68 obliterative, 25 restorative, and 5 reconstructive), but none on the aorta; he did refer to 7 AAAs, albeit treated with other procedures: ligature, wiring, electrocoagulation, etc.<sup>13</sup> By that time, Matas was 80 years old, so in all likelihood, he never performed his procedure on the aorta.

Lozano performed the first endoaneurysmorrhaphy for treating an AAA in 1904 (Zaragoza, Spain). As noted earlier, Matas,<sup>4</sup> Munro,<sup>5</sup> Bigger,<sup>6</sup> and others expressed their interest in Lozano's work. The first cases involving aortic endoaneurysmorrhaphy are listed in Table 1.

Rudolph Matas was 28 years old in 1888 when he first performed his endoaneurysmorrhaphy technique. When Ricardo

**TABLE 1.**  
**First Aneurysmorrhaphies Due to Abdominal Aortic Aneurysm (1904–1939)**

Author	Surgery Date	Hospital City (Country)	Publication, Year	Age/Sex	Presentation Etiology	Evolution Time
Lozano R	1904	University Hospital	La Clínica Moderna 1905	53/M	Symptomatic AAA	Death
	November 4	Saragossa, Aragón (Spain)			Syphilis?	Postoperative (6 hours)
Munro JC	1906	Carney Hospital	New York Med J 1906	39/M	Symptomatic AAA	Death
	May (Day NA)	Boston, MA (United States)			Arteriosclerosis	Postoperative (hours)
Crile GW	1907	Lakeside Hospital	Personal comm. 1907*	NA	AAA	Death
	Month NA	Cleveland, OH (United States)			NA	On the table
Gibbon JH	1908	Jefferson Hospital	JAMA 1912	45/M	Ruptured AAA	Death
	September 13	Philadelphia, PA (United States)			Arteriosclerosis	On the table
Kümmel H	1914	Allgemeinen Krankenhaus	Deutsch Med Wchnschr 1914	NA	AAA or TAA?	Death
	Month NA	Hamburg-Eppendorf (Germany)			Traumatic	Postoperative (hours)
Bigger IA	1939	Memorial Hospital	Ann Surg 1940	25/M	Ruptured AAA	Alive
	January 10	Richmond, VA (United States)			Traumatic	More than 1 year

\*To Rudolph Matas (Ann Surg 1940; 112:908).

AAA indicates abdominal aortic aneurysm; M, male; NA, not available; TAA, thoracic aortic aneurysm.

Lozano performed his unsuccessful aortic endoaneurysmorrhaphy in 1904, he was 32 years old. Matas was, therefore, 12 years older than Lozano, and we have not found any references at all that enable us to assert that they knew each other personally. By contrast, there is proof that they both knew of each other's work. Lozano, for his part, in his article, says "Before performing the surgical operation, I considered the procedure to be followed in this case and read the few studies that have been conducted on the matter. From all of these, I deduced that endoarteriorrhaphy, according to the method of Dr Matas, was the only one that would be successful.

A careful reading of the article by Lozano Monzón allows us to draw at least 3 conclusions<sup>9</sup>: First, he was well aware of Matas' endoaneurysmorrhaphy procedure, describing the advantages and drawbacks of its different variants. Secondly, he was aware of the therapeutic alternatives to endoaneurysmorrhaphy; he personally reviewed the 14 cases of AAA up until 1902 that had been treated with a ligature, reporting a 100% failure rate, and that other procedures, such the Moore-Corradi technique (wiring plus electrocoagulation), were of no use either in the cases of AAA used by William S. Halsted (1891) and John M. T. Finney (1898). Third, a year earlier, he had successfully performed an endoaneurysmorrhaphy to treat a popliteal aneurysm; it was the first one undertaken in Spain and also reported in La Clínica Moderna.<sup>14</sup>

The final years of the 19th century and the early years of the 20th were especially important for vascular surgery in Spain. Accordingly, the general history of vascular surgery suitably documents them in the contributions by Alejandro San Martín<sup>15</sup> and his disciple José Goyanes.<sup>16</sup> San Martín was acclaimed by Alexis Carrell as the precursor of latero-lateral arteriovenous anastomosis.<sup>17</sup> Goyanes is even better known than his mentor, largely because he created what subsequently became known as the Goyanes-Lexer procedure or the ideal treatment for popliteal aneurysms.<sup>18</sup> To some extent, the same happened to Lozano as to San Martín and Goyanes; by this, we mean they all published their original contributions in Spanish journals with little impact or dissemination outside Spain.

Returning to the subject of aortic endoaneurysmorrhaphy, there is a minor discrepancy (Table 1) between the cases described by Matas<sup>4</sup> and Bigger,<sup>6</sup> both in 1940. Bigger does not refer to John H. Gibbon's case<sup>19,20</sup> reported by Matas, and by contrast, he includes one of Kümmel's,<sup>21</sup> which Matas considered to be the first thoracic aneurysm treated, also unsuccessfully, through aneurysmorrhaphy. Nevertheless, until 1936, all the cases reported ultimately led to the patient's death.

Thirty years would have to pass after Lozano's operation until Bigger was able to report the first successful case. Nonetheless, Bigger's operation, as Matas acknowledged at the time, was a

restorative endoaneurysmorrhaphy performed on a very young patient with a traumatic aneurysm caused by a gunshot wound. In other words, it was a very different case to all the others from both a local and general perspective.

The different procedures involved in Matas' endoaneurysmorrhaphies (obliterative, restorative, and reconstructive), which were so effective in treating peripheral aneurysms largely affecting the limbs, did not record the same outcomes in cases of aortic aneurysms.

In 1947, Arthur H. Blakemore stated accordingly, "In the light of these circumstances, the best option for a patient with aneurysm is to restore the blood flow. The endoaneurysmorrhaphy that involves the inlay of a vein graft restores the arterial blood flow, without damaging the major collateral vessels."<sup>22</sup> This is, to a certain extent, what we do today when, for example, we treat an aneurysm in the common femoral artery.

Despite the huge leap forward made by Rudolph Matas in 1888, many years had to pass until a truly effective treatment was found for AAAs, which was achieved by Charles Dubost in Paris on March 29, 1951.<sup>23</sup>

The endoaneurysmorrhaphy technique, nonetheless, also had its reward. In 1966, the Dubost procedure was simplified and made safer when Oscar Creech (New Orleans, Louisiana) realized that the aneurysmatic sac, often firmly attached to the adjacent veins (iliac and vena cava), as in Dubost's original case, did not need to be resected, but simply opened; he, therefore, proposed the concept of intrasaccular reconstruction of the aneurysm with no resection.<sup>24</sup> The Creech procedure combines Matas' endoaneurysmorrhaphy with replacement of the lesion by a vascular prosthesis within the aneurysmatic sac, which is the treatment method currently being applied when we refer to open surgery on aortic aneurysms.

## ACKNOWLEDGMENTS

Our gratitude to María Jesús Marcos Blázquez, librarian in the Faculty of Medicine at Salamanca University. This work would not have been possible without her assistance.

## REFERENCES

1. Matas R. Ligation of the abdominal aorta: report of the ultimate result, one year, five months and nine days after ligation of the abdominal aorta for aneurism at the bifurcation. *Ann Surg.* 1925;81:457–464.
2. Matas R. Treatment of abdominal aortic aneurysm by wiring and electrolysis. Critical study of the Moore-Corradi method based upon the latest clinical data. *Trans So Surg Assoc* 1900;13:272.
3. Matas R. Traumatic aneurysm of the left brachial artery. *Med News Phil.* 1888;53:462–466.

4. Elkin DC. Aneurysm of the abdominal aorta: treatment by ligation. *Ann Surg.* 1940;112:895–908.
5. Munro JC. Aneurysmorrhaphy for abdominal aneurysm. Report of an un-successful case, with autopsy. *New York Med J.* 1907;85:681–683.
6. Bigger IA. The surgical treatment of aneurysm of the abdominal aorta: review of the literature and report of two cases, one apparently successful. *Ann Surg.* 1940;112:879–894.
7. Díaz-Rubio M. *Médicos españoles del siglo XX. Segunda serie*, Madrid, You & Us; 2003.
8. Zubiri VF. *Biografía del eminente cirujano D. Monzón RL*. Instituto Ultra; 1963.
9. Lozano R. Intervención quirúrgica directa en enfermo con aneurisma de la arteria aorta abdominal. Abertura del saco y arteriorrafía consecutiva. *La Clínica Moderna (Zaragoza)*. 1905;4:648–653 and 691–702 (continuation).
10. Lozano MR. Cirugía de la aorta abdominal. *Revista Universidad, Zaragoza, Tipografía “La Académica”*; 1929.
11. Ellis T, Widmann WD, Hardy MA. Rudolph Matas: the father of vascular surgery. *Curr Surg.* 2005;62:606–608.
12. Matas R. I. An operation for the radical cure of aneurism based upon arteriorrhaphy. *Ann Surg.* 1903;37:161–196.
13. Matas R. Personal experiences in vascular surgery: a statistical synopsis. *Ann Surg.* 1940;112:802–839.
14. Lozano MR. Arteriorrafía en aneurisma poplíteo. *La Clínica Moderna.* 1903;2:15–18.
15. San Martín y Satrustegui A. Cirugía del aparato circulatorio. Discurso leído en la solemne sesión inaugural en la Real Academia de Medicina. *Boletín Médico*; 1902.
16. Goyanes CJ. Nuevos trabajos de cirugía vascular. Sustitución plástica de las arterias por las venas o arterioplastia venosa aplicada como nuevo método al tratamiento de los aneurismas. *El Siglo Médico* 1906;53:561–564.
17. Carrel A, Guthrie CC. III. The reversal of the circulation in a limb. *Ann Surg.* 1906;43:203–215.
18. Friedman SG. *A History of Vascular Surgery*. Futura Publishing Company; 1989.
19. Gibbon JH. Further experience with aneurysmorrhaphy (Matas). Report of eight cases. *J Amer Med Assoc.* 1912;59:245–249.
20. Gibbon JH. Endoaneurysmorrhaphy: personal experience in 21 cases. *Ann Surg.* 1924;80:325–331.
21. Kümmel H. Chirurgie des aortenaneurysmas. *Deutsche Med Wochenschr (German Medical Weekly)*. 1914;40:731.
22. Blakemore AH. Restorative endoaneurysmorrhaphy by vein graft inlay. *Ann Surg.* 1947;126:841–849.
23. Dubost C, Allary M, Oeconomos N. Resection of an aneurysm of the abdominal aorta: reestablishment of the continuity by a preserved human arterial graft, with result after five months. *AMA Arch Surg.* 1952;64:405–408.
24. Creech O Jr. Endo-aneurysmorrhaphy and treatment of aortic aneurysm. *Ann Surg.* 1966;164:935–946.