Hybrid Repair of Thoracic and Thoracoabdominal Aortic Aneurysms (Mega Aortic Syndrome) With Lupiae Technique

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Objective: Several techniques have been described for the treatment of thoracic and thoracoabdominal aneurysms in patients with mega aortic syndrome (MAS), but the incidence of stroke, spinal cord injury, and endoleaks remains high. We present the midterm results of a new hybrid, multistep technique to treat patients with MAS.

Methods: From November 2005 to January 2011, 80 patients with MAS underwent hybrid repair of thoracic and thoracoabdominal aneurysms with the Lupiae technique. Forty-six patients presented with chronic aortic aneurysms, and 34 patients who had undergone aortic arch debranching with the Lupiae graft for acute aortic dissection presented with an expanding false lumen into the residual aorta. Sixty patients underwent ascending aorta and arch replacement with a Gelweave Lupiae prosthesis plus epiaortic vessel debranching (thoracic Lupiae procedure). Fourteen patients underwent a thoracic Lupiae procedure plus partial visceral debranching (celiac trunk and superior mesenteric artery) through a mini-laparotomy. Six patients underwent a thoracic Lupiae procedure plus a complete visceral debranching (celiac trunk, superior mesenteric artery, and renal arteries) with the implant of a second Lupiae prosthesis to replace the abdominal aorta. After the surgical steps, all the surviving patients underwent an endovascular procedure to implant multiple stent grafts to exclude the residual segment of diseased aorta.

Results: In-hospital mortality was 8.4%, and the incidence of temporary renal failure was 5.2%. None of the patients had a stroke or a spinal cord injury, and none of the patients presented endoleaks immediately following the procedure or during the follow-up computed tomography scans. No deaths occurred during the 6-year follow-up after the hybrid procedure.

Conclusions: These preliminary results showed that the Lupiae technique is a safe and effective option for the treatment of patients with MAS. Indeed, the Lupiae technique achieves complete exclusion of thoracic and thoracoabdominal aneurysms with a low risk of paraplegia and endoleaks.

Key Words: Thoracoabdominal aneurysms, Hybrid treatment, Aortic debranching.

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Mega aortic syndrome (MAS) can be defined as an extensive aneurysmal dilation of the ascending aorta, arch, and thoracoabdominal aorta. The incidence of MAS is 2.2 to 10 per 100,000, and the 5-year mortality is 100% if MAS is not treated.1–3 Myxomatous degeneration of the aortic wall and cystic medial necrosis are the most common etiologies for MAS. In addition, some patients with Marfan syndrome or chronic aortic dissection can be classified as MAS when the false lumen expands. Typically, patients with MAS are asymptomatic; however, they sometimes present with chronic chest or abdominal pain, dyspnea, dysphonia, or dysphagia. Patients with MAS also commonly present with acute aortic dissection, aortic rupture, or signs of peripheral ischemia caused by thromboembolism.4

The surgical repair of thoracic and thoracoabdominal aneurysm in patients with MAS is technically challenging and associated with a high mortality and morbidity.5,6 This study reports the preliminary results of an innovative, hybrid, multistep procedure that was designed to completely repair the thoracoabdominal aorta in patients with MAS. The Gelweave Lupiae graft (Terumo Vascutek, Renfrewshire, Scotland), a Dacron multibranch prosthesis (Fig. 1) which was designed to reroute the origin of the supraaortic vessels closer to the sinotubular junction, was implanted in all the patients to create a “fixed” elephant trunk into the Criado landing zone “0” for the implant of sequential endovascular stent grafts.

The Gelweave Lupiae prosthesis is constructed with a standard cylindrical Dacron graft (26–32 mm) with a trifurcated branch (10, 10, and 8 mm) coming off from a short main trunk (16-mm bovine-like trunk). Another 10-mm branch originates from the other side of the prosthesis. The Gelweave Lupiae prosthesis also presents a radiopaque marker immediately before the origin of the bovine-like...
trunk, which is necessary to correctly position the endovascular stent grafts. The name “Lupiae” derives from the “Roman age” name of Lecce, which is the Italian city where this procedure was first performed in 2005.

METHODS

From November 2005 to January 2011, 80 patients with MAS underwent surgical repair of thoracic and thoracoabdominal aneurysms with the Lupiae technique by a single surgeon (G.E.) at two institutions. Forty-six patients presented with chronic degenerative aneurysms of the ascending aorta, aortic arch, and descending aorta at the initial computed tomography scan. Forty-nine patients underwent emergency aortic debranching with the Lupiae graft for DeBakey Type I acute aortic dissection; however, only 34 of these patients presented with an expanding chronic dissection of the residual aorta after the surgical step and were included in this study.

All the patients underwent a surgical procedure that consisted of the replacement of the ascending aorta and the arch with the Lupiae prosthesis, the debranching of the aortic arch, and the reimplant of the supraaortic vessel on the branches of the Lupiae prosthesis. The distal extent of the aneurysm and the position of the distal landing zone (DLZ) significantly influenced the type of procedure that was performed, and the MAS patients were classified into three groups.

The MAS type I patients (Fig. 2) included two different subgroups: 26 patients had a chronic degenerative aneurysm that was >5 cm and originated at the level of the ascending aorta and terminated above the celiac trunk (CT), and 34 patients underwent a Lupiae technique for Type A acute aortic dissection and presented a residual false lumen >22 mm or a diameter of the dissected descending aorta >46 mm at the postoperative computed tomography scan. The MAS type I patients underwent a replacement of the ascending aorta and the aortic arch with the Lupiae prosthesis, the debranching of the aortic arch, and an implant of sequential stent grafts using the Lupiae prosthesis as the proximal landing zone and landing distally just above the origin of the CT (Fig. 3A). In 10 (12.5%) patients, the left subclavian artery (LSA) could not be reimplanted on the Lupiae prosthesis because it was too distal. Therefore, these 10 patients underwent a carotid-subclavian bypass through a left supraclavicular approach on the same day as the endovascular procedure.

The MAS type II patients (n = 14) presented with a chronic thoracoabdominal aneurysm that originated at the level of the ascending aorta and involved the CT and/or the superior mesenteric artery (SMA) but terminated above the renal arteries (RAs). The MAS type II patients underwent a similar procedure as the MAS type I patients except for the extension of the sternotomy into the upper abdomen (or the execution of a separate mini-laparotomy) to reimplant the CT and/or the SMA on the fourth branch of the of the Lupiae prosthesis, which was passed through the right side of the diaphragm. One month after the surgical procedure, the patients underwent a sequential endovascular stent-graft implant procedure that landed proximally on the Lupiae prosthesis and distally at the level of the lowest of the reimplanted abdominal branches (Fig. 3B).

In MAS Type III patients (n = 6), the thoracoabdominal aneurysm was extended below the RAs. Two surgical procedures were performed in these patients before the en-
dovascular procedure. The first procedure was identical to the procedure that was performed in the Type I patients. Three weeks later, the MAS type III patients underwent a laparotomy and a replacement of the infrarenal aorta with a second Lupiae prosthesis. The suprarenal aorta was then debranched, and the CT, SMA, and both RAs were reimplanted on the branches of the Lupiae prosthesis. One month after this second procedure, the patients were called again for sequential stent-graft implants. The implants landed proximally on the thoracic Lupiae prosthesis and distally on the abdominal Lupiae prosthesis (Fig. 3C), which was used as a Dacron DLZ.

Procedure Details

The Surgical Stage

Total intravenous anesthesia was used in all the patients, and both the left and the right radial arteries were cannulated for continuous blood pressure monitoring. Transesophageal echocardiography and near-infrared spectroscopy monitoring of cerebral oxygenation (INVOS cerebral oxymeter; Somanetics Corporation, Troy, MI USA) were routinely used. A full sternotomy was performed with a small left laterocervical incision for better exposure of the epiaortic vessels, particularly the LSA. In type II patients, the incision was extended 6 cm toward the umbilicus (or a separate mini-laparotomy was performed), and the CT and SMA were exposed above the level of the small gastric curvature. After opening the pericardium, the epiaortic vessels were extensively dissected in all the patients except those with Type A aortic dissection, in whom the epiaortic vessels were isolated and cannulated before opening the pericardium.

After a full dose of heparin was administered, the LSA was detached from the aortic arch and was anastomosed end-to-end with an 8-mm Dacron graft connected to a separate perfusion line. The innominate artery was then anastomosed end-to-side with a second 8-mm Dacron graft connected to the main perfusion line. A Y connection was positioned along the main arterial line. After positioning a two-stage venous cannula through the right atrium, the cardiopulmonary bypass was commenced through the graft that was anastomosed to the innominate trunk, and a 10 mL/kg/min separate flow was maintained into the LSA. The separate perfusion of the LSA was performed with moderate hypothermia (28°C) to reduce the risk of spinal cord injury. A vent was positioned into the right superior pulmonary vein. After cross-clamping the aorta, myocardial protection was achieved through the infusion of intermittent cold-blood cardioplegia. The ascending aorta was removed and, if necessary, an aortic valve repair or replacement was performed. The Lupiae prosthesis was then anastomosed to the sinotubular junction with the bovine-like trunk oriented upward and parallel to the superior vena cava and the fourth branch pointing downward. The lateral orientation of the side branches was also adopted to avoid graft compression after chest closure. The innominate trunk was then cross-clamped, and the flow to the brain was reduced to 10 mL/kg/min to maintain a perfusion pressure of 40 mm Hg to 50 mm Hg, which was measured in the right radial artery. In distal circulatory arrest with cerebral perfusion, the aorta was opened and the distal anastomosis was performed between the origin of the left common carotid and the LSA. Once this anastomosis was completed, the systemic perfusion was resumed by connecting the Y arterial line to the fourth branch of the Lupiae, and the rewarming was initiated.

During the rewarming period, the sequential connection of the left common carotid artery and the innominate trunk was performed with the 8- and 10-mm branches that originated from the bovine-like trunk. The cardiopulmonary bypass was discontinued, and the branch that was used for the arterial perfusion was anastomosed to the Dacron graft that was connected to the LSA.

In type II patients, the remaining branch that originated from the bovine-like trunk was tunneled through the right diaphragm into the retro-epiploic space and anastomosed sequentially to the CT and SMA with the interposition of a 6-mm armed Gore-Tex graft.

The Abdominal Procedure in MAS Type III Patients

Three or 4 weeks after the first surgical procedure, the patients with MAS Type III aneurysms underwent a full laparotomy. The infrarenal aorta was isolated from the iliac arteries to the RAs, and the inferior mesenteric artery was also isolated. The suprarenal aorta was then isolated above the small curvature of the stomach, and the origin of the CT and the SMA was isolated. After systemic heparinization, the abdominal aorta was clamped immediately below the RAs and resected down to the iliac bifurcation. The Lupiae prosthesis was implanted with the bovine-like trunk on the right and the branches pointing upward. The RAs were divided, and the distal ends were anastomosed to the branches of the Lupiae.

Two branches were then passed through the retro-epiploic space and anastomosed end-to-side to the CT and end-to-end to the SMA. The origin of the CT on the aorta was

FIGURE 3. Surgical repair of thoracoabdominal aneurysm with the Lupiae technique. (A) Repair for mega aortic syndrome type I. (B) Repair for mega aortic syndrome type II. (C) Repair for mega aortic syndrome type III.
tied to prevent endoleaks, and the inferior mesenteric artery was reimplanted to the main body of the prosthesis.

The Endovascular Procedure

The endovascular repair of the remaining diseased aorta was carried out 4 weeks after the surgical stage in patients with chronic aneurysms and from 1 week to 6 months after the surgical stage in the patients with Type A acute aortic dissections according to the diameter of the false lumen (>22 mm) and the diameter of the entire descending aorta (>46 mm). The procedures were performed in the cath laboratory under general anesthesia with continuous trans oesophageal echocardiography monitoring. The right femoral artery was generally exposed, and multiple self-expanding nitinol-framed stent grafts (Medtronic Vailant, Santa Rosa, CA USA) were deployed after systemic heparinization. The stent grafts started at the level of the radiopaque marker immediately after the origin of the bovine-like trunk and terminated at the distal landing zone (DLZ) according to the type of surgical repair that was performed. The oversizing of the stent grafts ranged between 5% and 10% of the aortic diameter.

Follow-Up

Follow-up periods ranged from 6 months to 6 years, and follow-up appointments were performed in 100% of the discharged patients. All the patients underwent a computed tomography scan after the surgical and the endovascular steps, 6 months after the completion of the endovascular step and then once a year at the time of the outpatient appointment.

Statistical Analysis

Categorical variables were presented as absolute numbers and percentages, and continuous variables were presented as the mean ± SD. All the statistical analyses were performed with the Stat-View 5.0 statistical software package (SAS Institute Inc., Cary, NC USA).

RESULTS

Preoperative and intraoperative data are depicted in Table 1. In terms of proximal procedures, aortic valve resuspension was performed in 63 patients (78.7%), aortic root replacement with a biologic valve conduit was performed in 3 patients, and a valve-sparing root replacement (David technique) was performed in 3 patients. Six patients underwent a replacement of the noncoronary sinus.

Seven patients died after the surgical procedures (7.3%): 3 of these patients were included in the group of 49 patients with DeBakey Type I aortic dissection, and the other 4 patients were in the group with a chronic aneurysm. The causes of death in the three patients who underwent an aortic dissection were uncontrollable bleeding during surgery from the rupture of the descending aorta (n = 1), right ventricular failure despite having an right ventricular assist device implanted (n = 1), and multiorgan failure (n = 1). In patients with chronic aneurysms, one patient died during the waiting period between the surgical and the endovascular steps because of aneurysm rupture, one Type III patient died after the visceral debranching because of bowel ischemia, and the other two patients died of sepsis. None of the patients experienced a stroke or paraplegia after the surgical procedures. Three patients with DeBakey Type I aortic dissection experienced postoperative cerebral transient ischemic attacks that resolved spontaneously without any brain CT changes. In addition, two patients (2.1%) required reexploration for bleeding. Moreover, three patients (3.1%) experienced renal failure and two of them required temporary dialysis. Furthermore, one patient underwent tracheostomy for respiratory failure (1%), and one patient had a superficial sternal wound infection (1%).

After the first step, all the 88 surviving patients were restudied with computed tomography scans. Among the 46 patients who survived the Lupiae procedure for DeBakey Type I aortic dissection, 34 patients presented a false lumen >22 mm or a descending aorta >46 mm and underwent the endovascular step. All the 42 surviving patients who underwent an operation for chronic aneurysms underwent the endovascular step. None of the patients at this stage declined the second procedure. The 12 patients who underwent an operation for DeBakey Type I aortic dissection who did not reach the criteria for the second step were excluded from the study because they did not undergo both of the procedures. These 12 underwent a computed tomography scan once a

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**TABLE 1. Preoperative and Intraoperative Characteristics of Patients With MAS Who Underwent the Lupiae Technique**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Preoperative</th>
<th>Intraoperative</th>
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</thead>
<tbody>
<tr>
<td><strong>Preoperative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>71.5 ± 5.8</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>58 (72.5)</td>
<td></td>
</tr>
<tr>
<td>CA stenosis &gt;50%</td>
<td>6 (7.5)</td>
<td></td>
</tr>
<tr>
<td>Preoperative CVA</td>
<td>7 (8.7)</td>
<td></td>
</tr>
<tr>
<td>Previous cardiac operations</td>
<td>1 (1.2)</td>
<td></td>
</tr>
<tr>
<td>CKD ≥3</td>
<td>5 (6.2)</td>
<td></td>
</tr>
<tr>
<td>Type A aortic dissections</td>
<td>34 (42.5)</td>
<td></td>
</tr>
<tr>
<td>Chronic aneurysms</td>
<td>46 (57.5)</td>
<td></td>
</tr>
<tr>
<td>DLZ above CT</td>
<td>26 (32.5)</td>
<td></td>
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<tr>
<td>DLZ above RAs</td>
<td>14 (17.5)</td>
<td></td>
</tr>
<tr>
<td>DLZ below RAs</td>
<td>6 (7.5)</td>
<td></td>
</tr>
<tr>
<td><strong>Intraoperative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPB time (min)</td>
<td>111.7 ± 25.1</td>
<td></td>
</tr>
<tr>
<td>Cross-clamp time (min)</td>
<td>49.8 ± 15.5</td>
<td></td>
</tr>
<tr>
<td>Circulatory arrest (min)</td>
<td>22.5 ± 3.2</td>
<td></td>
</tr>
<tr>
<td><strong>Endovascular</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients</td>
<td>76 (95)</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>54 (67.5)</td>
<td></td>
</tr>
<tr>
<td>Waiting period (wk)</td>
<td>4 ± 1</td>
<td></td>
</tr>
<tr>
<td>Procedure length (min)</td>
<td>235 ± 89</td>
<td></td>
</tr>
<tr>
<td>Contrast volume</td>
<td>198 ± 84</td>
<td></td>
</tr>
<tr>
<td>Femoral artery R/L</td>
<td>61/15</td>
<td></td>
</tr>
</tbody>
</table>

Values are given as N (%) or mean ± SD.

CA indicates carotid artery; CKD, chronic kidney disease; CPB, cardiopulmonary bypass; CT, celiac trunk; CVA, cerebrovascular accident; DLZ, distal landing zone; PVD, peripheral vascular disease; R/L, right/left; Min, minutes; RAs, renal arteries.
year during the follow-up without showing significant changes of the descending aorta diameter.

After the endovascular step, one Type I patient died of bowel ischemia. Interestingly, none of the patients presented type I-IV endoleaks at the end of the procedure. Two patients (2.1%) had right femoral artery dissection during the deployment of endovascular stent grafts and required a repair with the interposition of an 8-mm PTFE graft. In addition, two patients required temporary dialysis for acute renal failure. None of the patients experienced a stroke or paraplegia after the stent-graft implantation. In addition, none of the patients died or underwent further surgical or endovascular procedures during the follow-up. At the 6-month computed tomography scan, none of the patients showed any type of endoleak. In patients who had undergone the Lupiae technique for aortic dissection, false lumen thrombosis was achieved in 31 (93.9%) patients, whereas two patients had a partial thrombosis with a patent false lumen into the abdominal aorta.

**DISCUSSION**

Over the past three decades, different treatments have been advocated for patients with MAS. The standard treatment for MAS patients is the “elephant trunk” technique, which was introduced by Borst et al in 1983 and modified by Coselli et al in 1991. In this classic two-stage approach, the distal anastomosis on the aortic arch was constructed so that a portion of the graft was free-floating within the lumen of the proximal descending aorta. This “elephant trunk” was used in a subsequent surgical stage for distal aortic reconstruction through a large thoracophreno-laparotomy. One of the disadvantages of the “elephant trunk” technique was a significant incidence of aortic rupture during the waiting period (5 months on average), which ranged from 2.9% to 24.6%. The combination of the incidence of aortic rupture and a 10% in-hospital mortality brought the overall mortality of this two-stage approach to 19.2%.

Although the incidence of stroke and spinal cord injury seemed relatively low with the “elephant trunk” technique, these results are profoundly biased because almost 50% of these patients refused the second step of the procedure.

The single-stage surgical repair of thoracoabdominal aneurysms performed through a clamsheel incision, which has been described by Kouchookus et al, could address the problem of the deaths during the waiting period between the two procedures; however, the clamsheel incision is an extremely invasive procedure that is associated with high incidences of reopening for bleeding (17%), prolonged mechanical ventilation (42%), tracheostomy (13%), and dialysis (9%).

During the 1990s, the development of endovascular stent grafts allowed to combine the “elephant trunk” technique with a subsequent endovascular procedure to cover the remaining aorta. This approach was particularly attractive because it could reduce the invasiveness of the overall procedure and the interval between the two steps. Nevertheless, endovascular stent grafts were not suitable for patients with aneurysms extending below the CT (MAS Type II and III), and several technical problems have arisen from this type of procedure. In fact, the free-floating elephant trunk could be too short or too long, which could cause epiaortic vessel overstenting or paraplegia, respectively, due to the mobilization of clots attached to the free-floating elephant trunk. The free-floating elephant trunk could also be too small, which could cause anastomotic stenosis. Indeed, the mobility of a free-floating elephant trunk could make the endovascular stent deployment very difficult, and the curvature of the elephant trunk on the anastomotic site could be responsible for Type I endoleaks.

More recently, the development of the one-stage “frozen” elephant trunk claimed to overcome all these issues. Nevertheless, Ius et al analyzed the results of the frozen elephant trunk and reported a low mortality (5.6%), but a very high incidence of spinal cord injury (ranging from 2.8% to 22%) and endoleaks (ranging from 1.5% to 14.2%). Another limitation of this procedure is the impossibility of treating patients with aneurysms that involve the origin of the visceral vessels or that are very close to the origin of the visceral vessels. Ius et al concluded in his review that the “frozen” elephant trunk procedure should not really be considered a one-stage procedure for MAS because of the high incidence of endoleaks and the high rates of necessary further endovascular procedures.

Aortic arch debranching techniques have been developed more recently to reroute the origin of epiaortic vessels to create at least a 2-cm proximal landing zone for the implant of endovascular stent grafts. In the presence of a normal ascending aorta, aortic arch debranching could also be carried out without cardiopulmonary bypass, which makes the procedure particularly attractive in high-risk patients. A review by Ius et al examined 20 studies of more than 600 patients and found an average mortality rate for aortic arch debranching procedures of 8%. In addition, they found 5.8% and 1.6% incidences of stroke and spinal cord injuries, respectively, and a 16% incidence of endoleaks.

In our case series of 80 patients, the Lupiae technique outperformed these results, especially on the incidence of neurologic complications and endoleaks. We believe that the low rates of neurologic complications could be explained by three factors: (1) a relatively short distal circulatory arrest time, (2) the continuous perfusion through the LSA, and (3) the systematic reimplant of the LSA. This study found a circulatory arrest time of 22.5 ± 3.2%. This value and the rates of neurologic complications were consistent with the data reported by Glauber et al on a very similar aortic arch debranching technique, which confirmed the ease of execution and the reproducibility of aortic arch debranching techniques. In procedures like the frozen elephant trunk, however, where the distal arrest is generally longer (30–60 minutes according to different reports) due to a more complex distal procedure, the incidence of stroke and paraplegia is significantly higher. These findings could partially be explained by the risk of embolization.

The separate perfusion of the LSA could play a role in brain, spine, and visceral organ protection during distal circulatory arrest. Recently, Miyamoto et al demonstrated that perfusion through the LSA during circulatory arrest signifi-
cantly increases the collateral blood flow into the descending aorta and the blood flow through the stomach and the liver. We also believe that the systematic reimplant rather than the coverage of the LSA with an endovascular stent graft could significantly influence the complication rates. This view is in line with the current Society for Vascular Surgery clinical practice guidelines, which reported that the coverage of the LSA during thoracic endovascular aneurysm repair (TEVAR) procedures is associated with an increased risk of paraplegia, stroke, arm ischemia, and Type II endoleaks. The guidelines recommend LSA reimplant in all the patients who undergo elective TEVAR with the involvement of the LSA.

Another strength of the Lupiae technique is its ability to minimize endoleaks, thrombosis of the false lumen, and the need for further surgical or endovascular treatments. The position in Criado zone 0, the length of the proximal landing zone (always ≥2.5 cm), the systematic reimplant of the LSA, and the creation of a new DLZ by partially or completely debranching the abdominal aorta seem to be important factors for preventing the onset of endoleaks and allowing very high false lumen thrombosis rates.

Since the 1990s, several retrospective series have analyzed the risk factors that are associated with the late expansion of the residual false lumen in patients who underwent emergency surgery for acute aortic dissection. The 10-year distal reoperation rate after conventional surgery for aortic dissection ranges between 16% and 26%, and the patency of the false lumen seems to be a critical factor in the dilatation of the residual aorta, the reoperation rates, and the long-term prognosis of the patients. In patients with acute aortic dissection, Song et al demonstrated that a false lumen diameter >22 mm in the descending aorta predicted the development of a late aneurysm with a sensitivity of 100% and a specificity of 76% and was associated with worse long-term survival. These data are in line with our approach in patients with DeBakey Type I aortic dissection, and we proceeded with the endovascular stage in all the patients with early signs of residual false lumen expansion.

Although the timing for the endovascular procedure was fixed in chronic patients (3 or 4 weeks), it could vary between 1 week and 6 months in DeBakey Type I aortic dissection according to the progression of the false lumen of the residual aorta.

The main limitations of this study were the retrospective design, the lack of a randomized control group, and the small sample size. Few observational studies on the long-term fate of a patent false lumen after aortic dissection repair confirm and support our endovascular strategy, but more solid evidence can only be obtained from randomized trials.

In conclusion, hybrid aortic repair is emerging as an easier and safer procedure for thoracic and thoracoabdominal aortic aneurysms. Developing an accurate classification system for hybrid aortic procedures is the first step toward understanding the safety and efficacy of various techniques that are used for hybrid procedures. In addition, an accurate classification system can provide criteria to allow for comparisons between the hybrid procedures and standard open surgical methods. In the present series, the Lupiae technique was a valid alternative to treat patients with MAS who showed a lower incidence of complications compared with the “frozen” elephant trunk, and the Lupiae technique allowed us to reduce the waiting period and the invasiveness of the procedure compared with the traditional “free-floating” elephant trunk. In our experience, the debranching of the suprarenal aorta followed by the deployment of endovascular stent grafts is a safer and less complex option compared with the replacement of the suprarenal aorta, and the debranching of the suprarenal aorta was an essential step in the treatment of extensive thoracoabdominal aneurysms. A prospectively designed study and a longer follow-up are required to obtain more data on the long-term performance and reliability of the Lupiae technique.

REFERENCES

**Clinical Perspective**

This large series of 80 patients from Dr. Esposito and his colleagues from Bari, Italy, evaluated the midterm results of a new hybrid multi-step technique to treat patients with mega aortic syndrome. The patients all were treated with the Gelweave Lupiae graft, which is a Dacron multibranched prosthesis. In-hospital mortality was 8.4% and the incidence of temporary renal failure was 5%. None of the patients had a stroke or spinal cord injury and there were no endoleaks at the 6-month followup computed tomography scan.

This report adds to the growing literature on new hybrid procedures to treat complex patients with thoracoabdominal aneurysms. These procedures are encouraging and have the potential to significantly improve outcomes. The low rate of neurologic complications in this trial can be explained by the relatively short distal circulatory arrest time, as well as continuous perfusion, and when indicated, systemic reimplantation of the left subclavian artery. The main limitations of the study were its retrospective design and the lack of a control group. Further evidence will be needed to define the long-term outcomes and reliability of this novel technique. However, this study, as well as others, suggest that hybrid aortic repair continues to evolve and has the promise of decreasing the difficulty and morbidity of complex thoracoabdominal aneurysm repairs.