Clinical Case Report

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Favorable remodeling after hybrid arch debranching and modified provisional extension to induce complete attachment technique in type a aortic dissection

A case report

Arkadiusz Kazimierczak, MD, PhD[a,*], Tomasz Jedrzejczak, MD, PhD[b], Paweł Rynio, MD[a], Szymon Waligórski, MD, PhD[b]

Abstract

Rationale: Type A aortic dissection (TAAD) usually requires emergency open repair of the ascending aorta. In cases of diffuse dissection that spreads along the descending and abdominal aorta (type I, DeBakey classification), the risk of aneurysmal degeneration varies between 30% and 50% during 5 years and increases even higher during a longer follow-up. Those patients might require complex intervention to prevent aortic rupture. A combination of hybrid arch debranching and the extended provisional extension to induce complete attachment (e-PETTICOAT) technique might be an available alternative in such cases. This is the first report of the successful use of the e-PETTICOAT technique for treating degenerative, diffuse TAAD.

Patient concerns: Acute chest pain and syncope were the initial symptoms of diffuse TAAD in our 66-year-old female patient. Open replacement of the ascending aorta followed by surgical arch debranching was performed as a staged procedure. Unfortunately, progressive aneurysmal degeneration was revealed 6 months later in the thoracic, abdominal, and infrarenal aorta with the recurrence of chest and lumbar pain.

Diagnoses: Computed angiotomography revealed severe aneurysmal degeneration of aortic dissection in the thoracic and abdominal aorta.

Intervention: The e-PETTICOAT enabled good remodeling and stopped degeneration.

Outcome: At the 2-year follow-up, good remodeling with complete false lumen thrombosis and a stable aortic size were confirmed.

Lesson: Lifelong follow-up in extensive TAAD should be considered. The e-PETTICOAT technique is an available alternative to fenestrated endovascular aortic repair for degenerative TAAD, as it promotes favorable remodeling after successful surgery of the ascending aorta.

Abbreviations: BEVAR = branched endovascular aortic repair, BMS-XL = extra large bare metal stent, CERAB = covered endovascular reconstruction of aortic bifurcation, CTA = computed angiotomography, e-PETTICOAT = extended provisional extension to induce complete attachment, FEVAR = fenestrated endovascular aortic repair, FL = false lumen, IA = innominate artery, KS = kissing stents, LCCA = left common carotid artery, LRA = left renal artery, PETTICOAT = provisional extension to induce complete attachment, RRA = right renal artery, TAAD = type A aortic dissection, TL = true lumen.

Keywords: Aortic dissection, CERAB, Kissing stents, modified PETTICOAT, PETTICOAT

1. Introduction

Type A aortic dissection (TAAD) (Stanford classification) is a life-threatening condition that occurs in 60% of cases of aortic dissection.[1,2] The criterion standard for treating TAAD is emergency open surgical replacement of the ascending aorta.[1] Nevertheless, successful open surgery of the ascending aorta, such as in extensive dissection with distal re-entry in the abdominal aorta or iliac artery (type I, DeBakey classification), often fails to induce remodeling in the long-term and may create challenges in preventing and treating complications.[3–5] Hemodynamically, TAAD is similar to extensive type IIIB dissection, which might have a degenerative effect on the aneurysm with a high risk of rupture. This happens in about 50% of cases in the long-term follow-up.[6–10] Consequently, complex surgical intervention is needed in 30% of cases over 5 years. Moreover, its incidence increases by about 10% yearly in the long term.[8,10] Currently, patients with degenerative dissection are candidates

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Informed consent was obtained for publication of this case report and accompanying images.

The authors report no conflicts of interest.

[a] Department of Vascular Surgery, [b] Department of Cardiosurgery, Pomeranian Medical University in Szczecin, Szczecin, Poland.

[*] Correspondence: Arkadiusz Kazimierczak, Department of Vascular Surgery, Pomeranian Medical University, No. 72 Powstancow Wielkopolskich Road, Szczecin 70-111, Poland (e-mail: biker2000@icloud.com).

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for complex endovascular procedures (fenestrated endovascular aortic repair [FEVAR] or branched endovascular aortic repair [BEVAR]) or classic open repair, although this is associated with a high death rate because of complications, including paraplegia.[11–13] A combination of hybrid arch debranching and the extended provisional extension to induce complete attachment (e-PETTICOAT) technique in complicated and progressively degenerative, extensive TAAD might result in good remodeling and stop the progression of degeneration. This is the first report of the successful use of the e-PETTICOAT technique for treating degenerating type A dissection as an available alternative to FEVAR.

2. Case report

Informed consent was obtained for publication of this case report and accompanying images. A 66-year-old woman presented with sudden-onset chest pain and syncope. Computed angiotomography (CTA) revealed TAAD (Stanford classification)/type I (DeBakey classification) with entry in the ascending aorta and distal re-enty in both common iliac arteries. The aortic valve was competent. The ascending aorta was replaced with a tube graft. Two years after the procedure, symptomatic aneurysmal arch degeneration of 76 mm was revealed (Fig. 1).

The innominate artery (IA) and left common carotid artery (LCCA) were dissected, and no neurological complications were noted. The sizes of the thoracic, abdominal, and infrarenal segments of the aorta were 38, 32, and 26 mm, respectively. The true lumen (TL) was compromised in the thoracic and abdominal aorta, with distal re-entry in both common iliac arteries. Visceral branches were patent and supplied by the TL. The left renal artery (LRA) was supplied by the false lumen (FL). The TL volume was 87 mL, and total FL volume was 209 mL. Contrast-enhanced CTA showed no thrombosis in the FL.

After obtaining consent, surgery was performed. All procedures were performed under general anesthesia. A cerebrospinal drainage tube was inserted preoperatively (before e–PETTICOAT) as a preventative measure, and it was to be opened only in the case of paraplegia. Arch debranching was conducted using bifurcated bypass to the IA and LCAA. Then a stent graft (Valiant, Medtronic, Santa Rosa, CA) was implanted in the aortic arch and descending aorta (Fig. 2).

Sixth months postoperatively, CTA showed further disease progression, and the patient reported recurrence of chest pain. The size of the thoracic aorta increased to 49 mm, that of the abdominal aorta increased to 36 mm, and that of the infrarenal aorta increased to 30 mm. The thoracic stent graft collapsed because of FL expansion. However, the visceral branches did not show substantial change. The following new risk factors were apparent in the thoracic aorta: total aortic size >4 cm, FL size >22 mm, partial FL thrombosis, and fast aortic growth >5 mm within 6 months.[10,14–16] The FL volume increased to 248 mL. However, the contrast-enhanced FL volume remained at 84 mL because of partial thrombosis. The TL was still narrow (TL volume 93 mL), so another procedure was considered.

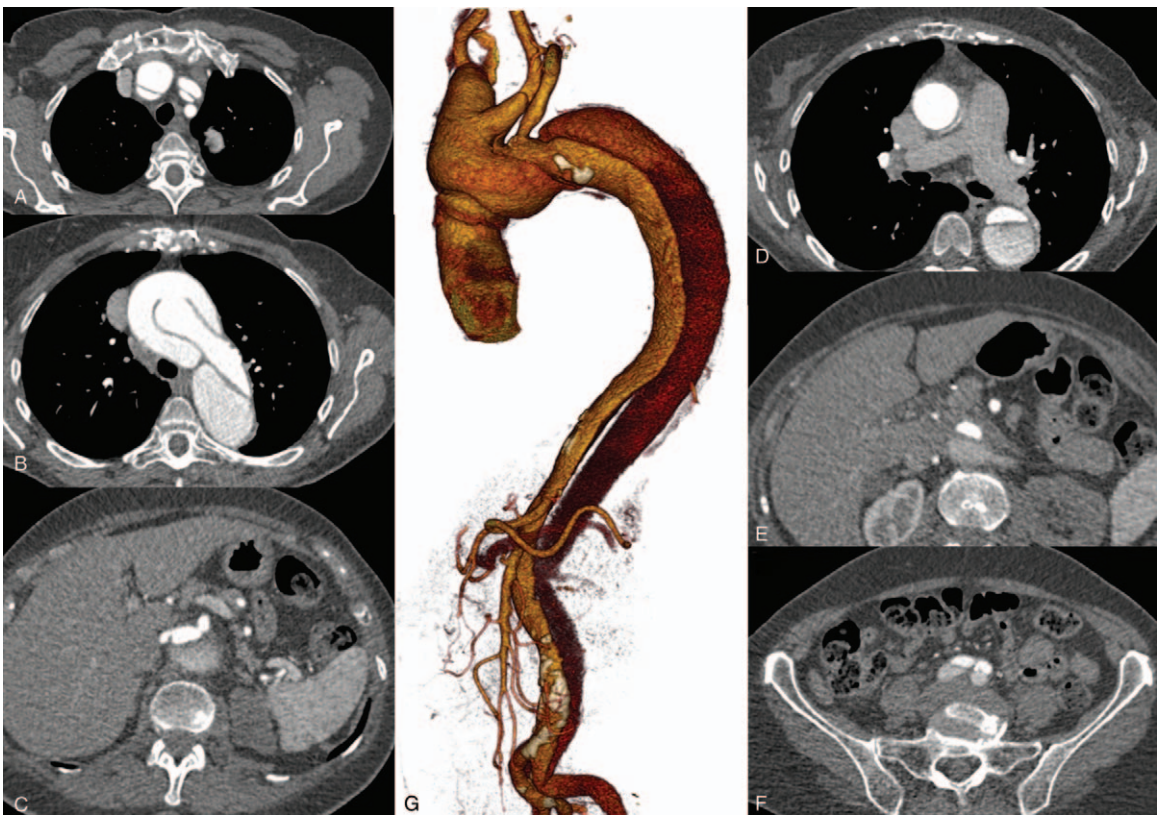

Figure 1. A computed angiotomography of aortic dissection before surgery (G). The aortic arch (B), the innominate artery (A), the left common carotid artery (A) and both iliac arteries are dissected (F). The true lumen in the thoracic and visceral aorta is severely compressed (C, D). The left renal artery is completely detached (E).

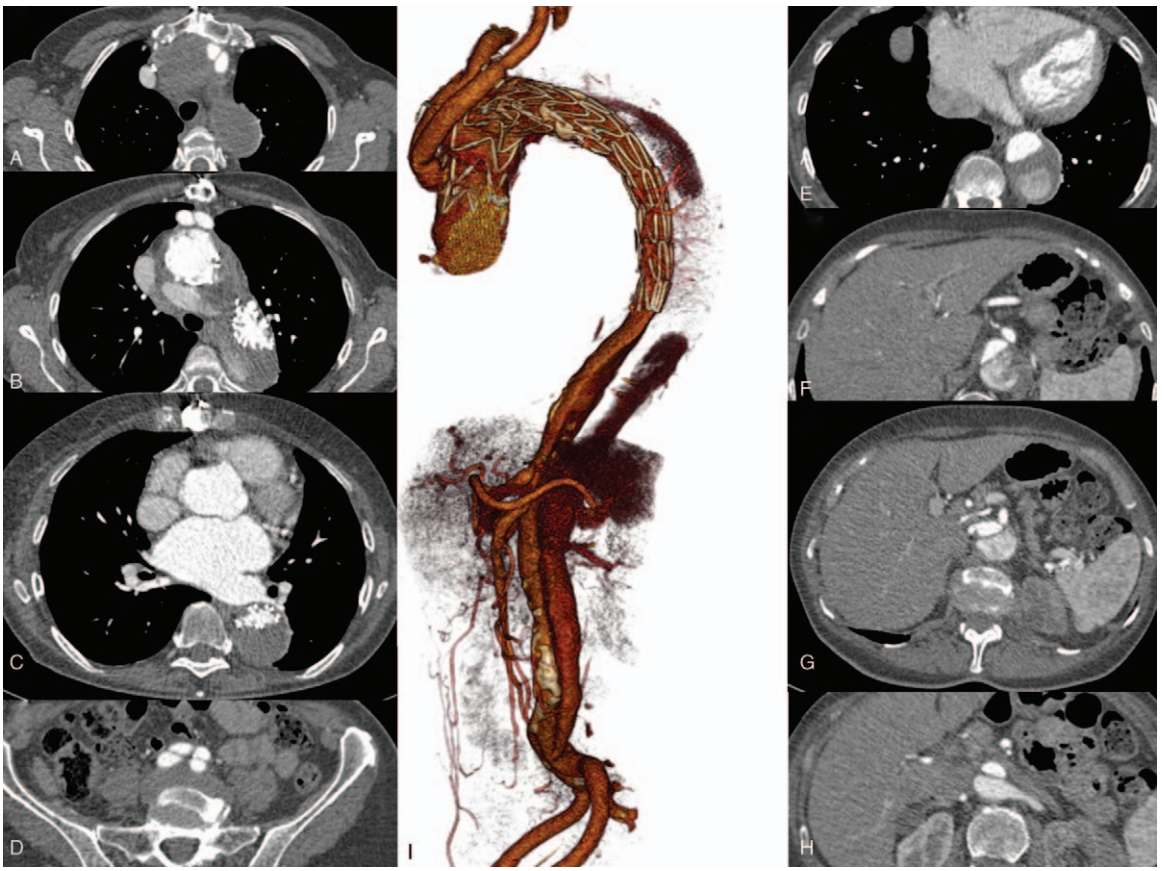

Figure 2. The degeneration of a dissected aorta after arch debranching, from computed angiotomography (I). The aortic arch size increases (A). The false lumen (FL) is partially perfused (B) and compressed TL in thoracic and visceral aorta (C, G). Distal re-entry supplies the flow inside the FL of both iliac arteries (D). FL is partially thrombosed in the thoracic and visceral aorta (E, F). The left renal artery is still patent and supplied from FL (H).

As an alternative to the provisional extension to induce complete attachment (PETTICOAT), thoracic endovascular aortic repair, or covered endovascular reconstruction of aortic bifurcation (CERAB), modifications were made for the first time to the PETTICOAT technique, and it was referred to as e-PETTICOAT. This new technique was developed to close the distal re-entry and support the TL. The procedure was conducted after obtaining additional patient consent. The complete operative data are presented in Figure 3.

A 200-mm long, 36-mm wide bare metal self-expandable stent (Medicut, Pforzheim, Germany) was deployed in the visceral and infrarenal aorta over the aortic bifurcation. Afterward, a 46-mm wide, 200-mm long thoracic stent graft (Talent, Medtronic) was deployed where the previously implanted thoracic stent graft was located, and it overlapped the extra large bare metal stent (BMS-XL). Oversizing (5% to 10%) was based on the size of the aorta and the earlier implanted stent graft at the planned landing zone. Forced ballooning of all devices was performed (Tri-Lobe Balloon Catheter, Gore, Flagstaff, AZ). Finally, 2 covered stent grafts (Endurant II, Iliac Extension, Medtronic) were placed between the renal arteries and both common iliac arteries (parallel kissing iliac stent grafts), within the BMS-XL. By using the kissing balloon technique, those stents were expanded with 2 Reliant stent graft balloon catheters (Medtronic). Final angiography showed no FL leakage and patency of all visceral branches, including the previously occluded LRA. The mean arterial pressure was maintained within 80 to 100 mmHg intraoperatively and postoperatively. The intravenous dosage of heparin varied between 50 and 80 mg in relation to the activated clotting time of 200 to 250 seconds.

A remodeling assessment was performed using Osirix software (Pixmeo SARL, Geneva, Switzerland) preoperatively and at months 1, 12, and 24 after e-PETTICOAT was performed, and it showed that favorable remodeling was achieved. The size of the aorta decreased in the arch (45 mm), descending (45 mm), abdominal (32 mm), and infrarenal aorta (28 mm). The FL was completely closed, and its volume decreased to 45 mL. The TL volume increased to 434 mL. Favorable remodeling was confirmed by volumetric analysis (Fig. 4).[17] After 24 months of follow-up no symptom or complication, such as paraplegia, stroke, or other neurological complication, was noted. All visceral branches, including the LRA, were fully patent. Kidney function was within normal limits, and arterial pressure was well controlled.

3. Discussion

The criterion standard treatment for TAAD is open or hybrid surgery followed by the best medical care.[1,18] However, late degeneration of the distal aorta remains one of many risk factors following treatment.[1,14,19] Endovascular aortic repair in chronic aortic dissection is still controversial in types A and B dissection.[20,21] In the case of chronic and degenerative type B

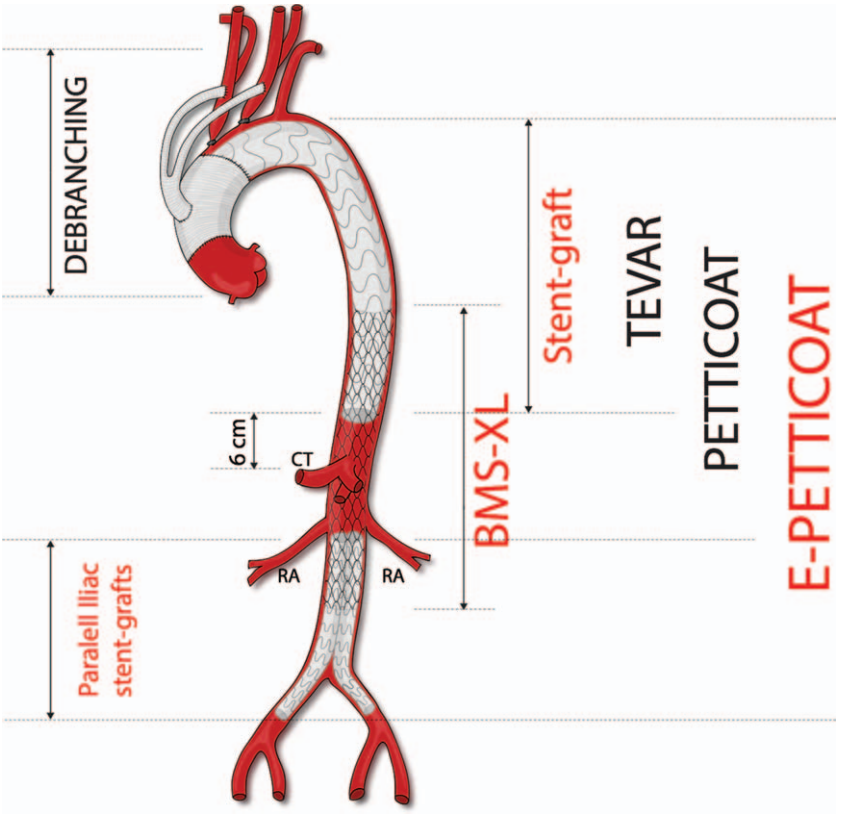

Figure 3. An extended provisional extension for the induced complete attachment technique.

dissection, BEVAR or FEVAR is usually recommended.[11] There are reports about the successful use of Multilayer Flow Modulator stents for aortic dissection.[22] Nevertheless, there is little or no consensus regarding use of this method. The technique presented herein is new and different from the classic PETTICOAT or Stable technique,[23,24] as it extends toward the infrarenal aorta and both iliac arteries (parallel stent grafts). It shares similarities with CERAB,[25,26] but it has a noteworthy difference (Fig. 5).

Instead of CERAB, we used bare metal self-expandable stents to re-attach the membranes and to protect all branches in the abdominal and infrarenal aorta, which is similar to the concept behind the Stable and PETTICOAT techniques.[23,24,27] In our modification, the dissected intima acts as a sheet of custom-made fenestrated stent graft. It prevents blood flow to the bowels, kidneys, and spinal cord. This small modification to classic PETTICOAT makes this technique safer to use in dissection. A crucial step in its success is an increase in the radial force of the aortic bare metal stent (BMS). Consequently, the BMSs were supported from above by the implanted stent graft that overlapped them,[28] and from below by the iliac parallel covered stent graft. This prevents leakage from re-entry and reinforces the radial force of the distal area of the BMS. These stent grafts covered the 2 BMSs (kissing stents [KSs]).[29] Furthermore, the combination of using a BMS-XL with parallel iliac stent grafts diminishes radial mismatch between the grafts, which is also observed in CERAB.[29] The main difference between the CERAB, KS, and e-PETTICOATS techniques is shown in Figure 5.

We use the e-PETTICOAT technique on a regular basis in cases of degenerative or complicated type B dissection with reasonably good results. However, a limitation of this technique is that the largest available BMS-XL measures 46 mm. Therefore, in cases of severe degeneration wherein the abdominal aortic size exceeds 40 mm, the effectiveness of e-PETTICOAT is limited. Nevertheless, the present case shows that the e-PETTICOAT technique is also available and effective for treating TAAD, and it is an available alternative to FEVAR.

Lifelong follow-up of extensive TAAD should be considered. Additionally, the e-PETTICOAT strategy may be used in degenerative TAAD, as it promotes favorable remodeling after successful repair of the ascending aorta.

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Author contributions

Conceptualization: Arkadiusz Kazimierczak, Tomasz Jedrzejczak, Pawel Rynio.
Data curation: Tomasz Jedrzejczak.
Formal analysis: Arkadiusz Kazimierczak.
Investigation: Arkadiusz Kazimierczak, Pawel Rynio, Szymon Waligórski.
Methodology: Arkadiusz Kazimierczak, Pawel Rynio, Szymon Waligórski.

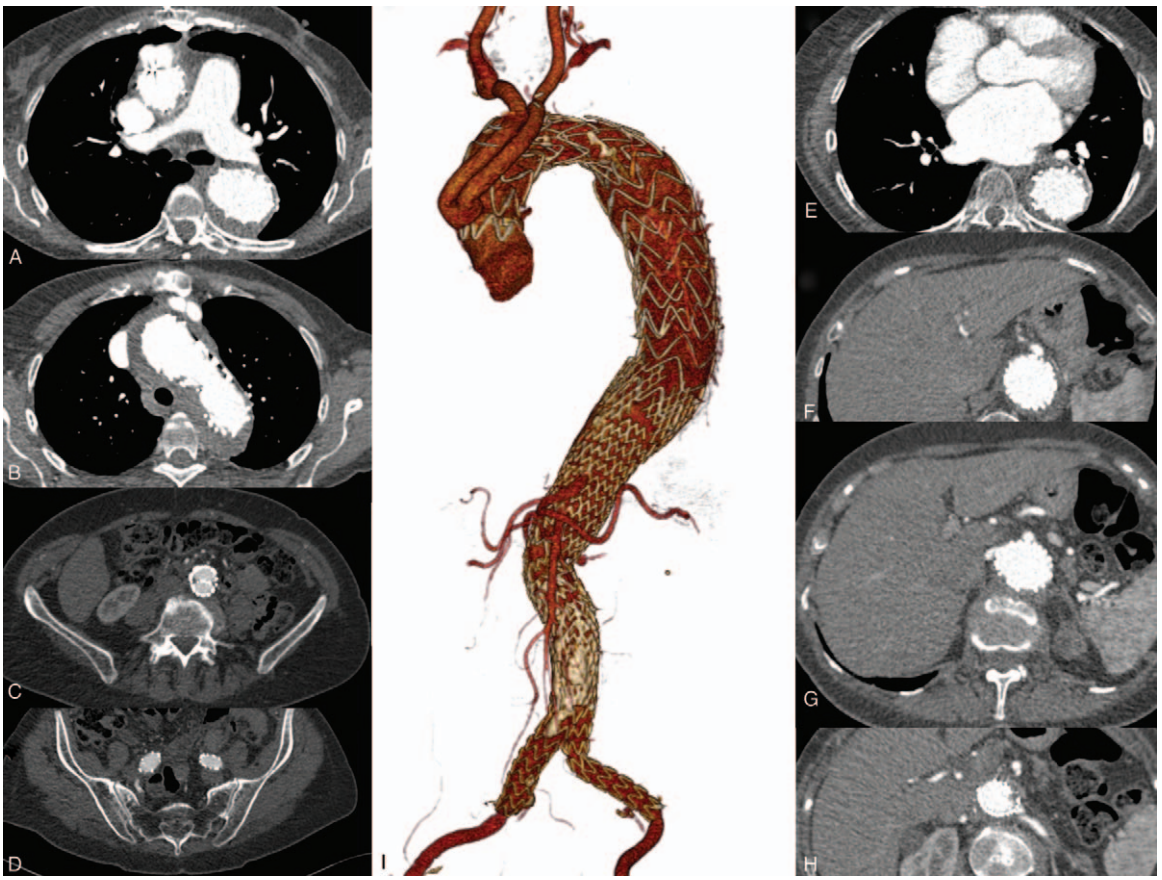

Figure 4. A computed angiotomography volumetric rendering of favorable aortic remodeling after an extended provisional extension for the induced complete attachment technique (I). Complete true lumen (TL) restoration and thrombosis of the FL occurred in the ascending aorta (A), as well as in the aortic arch (B), thoracic (E), visceral (F, G, H) and infra-renal segment (C, D). All visceral arteries remain patent (F, G, H). Left renal artery arises from the TL (H).

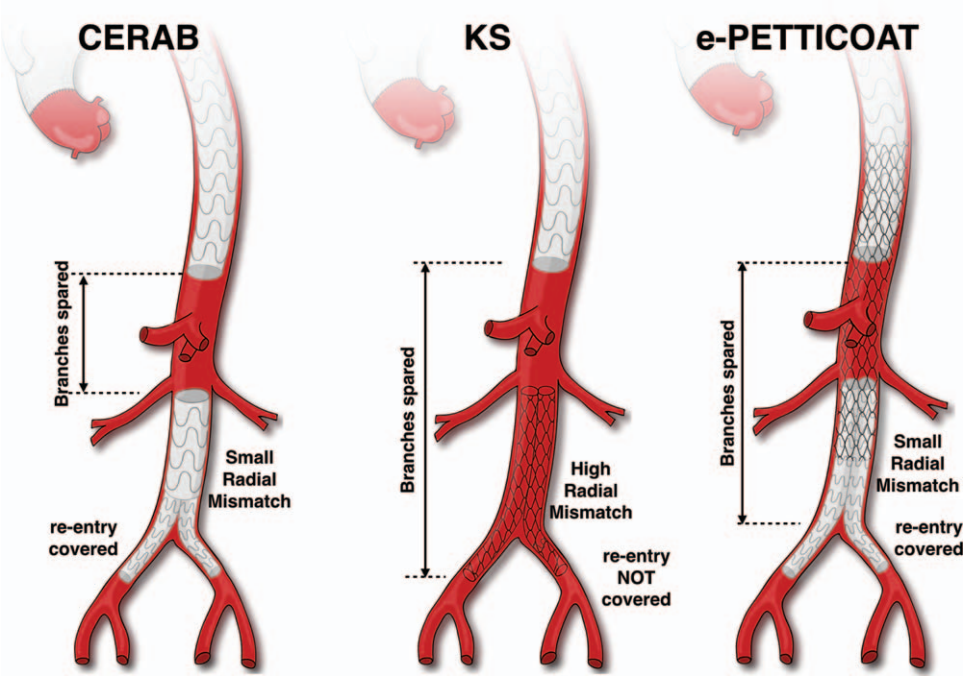

Figure 5. Illustration of the difference between a covered endovascular reconstruction of aortic bifurcation (CERAB), kissing stent (KS), and extended provisional extension for the induced complete attachment (e-PETTICOAT) technique.

Supervision: Arkadiusz Kazimierczak, Szymon Waligórski.
Visualization: Arkadiusz Kazimierczak, Tomasz Jedrzejczak.
Writing – original draft: Arkadiusz Kazimierczak.
Writing – review & editing: Tomasz Jedrzejczak, Pawel Rynio.
Arkadiusz Kazimierczak orcid: 0000-0002-6670-927X.

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