Parallel Endograft (Sandwich Technique) to Treat Aorto-Iliac Aneurysms; Faesibity and Short-Term Outcomes

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ABSTRACT

Background: *Up to 20-30% of Abdominal Aortic Aneurysms (AAA) have concomitant common iliac artery aneurysms that continues to be troublesome is their management keeping in mind the possible clinical significance of sacrificing the hypogastric arteries (HGAs) for effective AAA treatment.* ***Method****: Parallel endograft (sandwich technique) was offered to patients with abdominal aortic aneurysm associated with unilateral or bilateral common iliac artery (CIA) aneurysms with or without hypogastric artery (HGA) aneurysm presented at vascular surgery department, Cairo university hospitals between March 2014 and September 2016.* ***Results****: 5 patients underwent parallel endograft endovascular aneurysm repair (PG-EVAR) for infra-renal abdominal aortic aneurysms associated with unilateral or bilateral common iliac with or without hypogastric artery aneurysms. Four patients were males (80%), presenting a median age of 77 years (range 66-88 years). The median length of the procedure was 105 minutes (80-210 minutes), fluoroscopy time minutes (15-50 minutes), IV contrast dose 85 mL (50-180 mL), and average estimated blood loss 55 mL (30-400 mL). A total of 6 self expanding covered stents (4 Fluency stents & 2 Viabhan stents) were used with 6 SMART Control self-expanding bare-metal stents for relining to attain better HGA endograft apposition and prevent compression by the ILE. One patient presented with immediate post-operative right arm weakness due to cerebral infarction. Another patient developed postoperative severe respiratory insufficiency due to severe chronic obstructive pulmonary disease. The overall hospital stay was at a median of 3 days (2-20 days). Neither type I nor type III endoleaks were detected at follow up. Only one case showed mild aneurismal sac enlargement at 6 month follow up due to persistent type II endoleak .Follow-up CT and Duplex scans showed patency of all Viabhan and Fluency grafts without in-stent re-stenosis at a median follow-up of 6 months (range 3-10 months).* ***Conclusion****: our limited series indicates that the sandwich technique is a technically safe and effective technique for the preservation of HGA circulation. In our opinion, it has the advantage of expanding the applicability of EVAR for AAA with complex iliac artery anatomies. However, further studies with more long-term data are required to confirm the safety and efficacy of the sandwich technique.*

Key words: *Aneurysms, Parallel graft, Aorto-iliac*

INTRODUCTION

In 20-30 % of cases abdominal aortic aneurysms (AAA) occur in association with iliac aneurysms.[1] Endovascular management of the AAA in these patients is complicated by inadequate sealing of the iliac limb of the stent graft.[2] The most frequently used endovascular options are either the bell-bottom (flare limb) technique or iliac extension to the external iliac artery and hypogastric artery embolization.[3] Those techniques are burdened by a lot of complications including disconnection of the graft components, gluteal claudication, ischemic colitis, neurological deficit and erectile disfunction.[4-7] The advent of branched iliac devices has greatly improved endovascular treatment, and they have shown good results even in long-term follow-up data, but the problem is that those devices are expensive and not adequate for all anatomies (angulated and narrow aortic bifurcation; short length of common iliac artery).[8] The parallel endograft (sandwich technique) provides adequate aneurysm exclusion with revascularization of the hypogastric arteries with much fewer anatomic limitations. Here we present our experience in management of patients with AAA in association with unilateral or bilateral iliac artery aneurysms using the sandwich technique to preserve the hypogastric arteries.[9-14]

MATERIALS & METHOD

Parallel endograft (sandwich) technique was offered to selected patients with abdominal aortic aneurysm associated with unilateral or bilateral common iliac artery (CIA) aneurysms with or

without hypogastric artery (HGA) aneurysm presented at vascular surgery department, Cairo University Hospitals, between March 2014 and September 2016. An informed consent was obtained for every individual patient. . The preoperative data included: age, gender, presenting symptoms, size and type of aneurysm (true or false), type of stents used and complications. AAA measurements were carried out on a PC workstation with the help of dedicated software; Osirix Pro 4.0 software (Pixmeo, Geneva, Switzerland). All patients were treated by Endurant IIs bimodular stent graft (Medtronic Inc., Minneapolis, MN, USA) for their AAA repair with the following inclusion criteria according to manufacturer IFU: adequate iliac/femoral access, neck diameters of 19-32 mm, proximal necks ≥10 mm if infrarenal angle ≤60° and ≤45° suprarenal angulation, Or proximal necks ≥15 mm with ≤75° infrarenal and ≤60° suprarenal angulation and Iliac diameters (non aneurysmal side) of 8-25 mm. Regarding the iliac aneurysm side we mandate at least 8 mm diameter of the external iliac artery and at least 2 cm of at least 6 mm distal main stem hypogastric artery (in case of associated hypogastric aneurysm)

In addition to the standard bi-modular Endurant II device we used self-expandable covered stents length of which should provide at least 2 cm distal landing at hypogastric artery as well as 5 cm overlapped segment within the AAA stent graft's iliac limb. Self-expandable Nitinol stents were used for these covered stents relining and distal anchorage. The procedures were performed in the angiography suite under general anesthesia, in all procedures prophylactic 2nd generation cephalosporin broad spectrum antibiotics were routinely given before skin incision and continued for 24 hours postoperative. Bilateral surgical femoral exposures were performed together with a left percutaneous brachial artery access.

Technical details:

The sandwich technique was first described by Lobato.[8] The technique basically consists of the deployment of a combination of the commonly used standard stent grafts together with parallel endografts. Following full deployment of the bi-modular stent graft Endurant II (while keeping the corresponding stiff wire in place) with positioning of the iliac limb of the stent graft (at the common iliac aneurysm side) to end at 10-20 mm distance from the origin of the hypogastric artery, and its distal diameter is 20-25% less than the sum of the chosen covered stent and the chosen external iliac extension limb. The extension limb length should provide 4 cm overlapped segment within the iliac limb and at least 2 cm distal landing at the external iliac artery with 10-15% diameter oversize to the external iliac artery diameter. To proceed with the sandwich technique, the hypogastric artery is cannulated with hydrophilic wire and appropriate angiographic curved catheter via the brachial access followed by exchange to 2 cm floppy tip extra-stiff guidewire. Then the covered stent is inserted with at least 2 cm distal landing at the normal hypogastric artery and kept un-deployed and overlapping at least 5 cm within the corresponding iliac limb. Then via the corresponding femoral access an iliac limb extension stent graft is deployed (trailed along the stent graft stiff wire) alongside the covered stent taking care of at least 4 cm overlapped segment within the corresponding iliac limb of AAA stent graft with its proximal end is positioned 10 mm distal to the proximal end of the alongside covered stent. Only after iliac limb extension is deployed the previously inserted covered stent (the chimney graft) is deployed. A self-expandable nitinol stent of the same diameter and length is used for relining of the deployed covered stent to avoid kinking and future occlusion. Ballooning of either the iliac extension or the relined covered stent was only mandatory if there is type Ib endoleak of more than 50% lumen compression. In case of bilateral CIAAs, the contra lateral iliac limb was deployed and the procedure. At completion angiogram, any evident type I or III would call for post-deployment ballooning. . Mobilization of the patients was performed on the second postoperative day. Technical success was defined as proper device placement, cannulation and stenting of the hypogastric arteries, absence of type I and III endoleaks, no lumen compression greater than 50%, no acute limb occlusion and no perioperative mortality as described by Greenberg et al.[15]

Follow up:

For follow-up clinical examination as well as duplex ultrasound, contrast-enhanced CT scans and plain radiographs were obtained before hospital discharge and again at 3 and 6 months

looking for endoleaks, graft patency and any manifestations of buttock claudication. Re-intervention, sac morphology changes and endoleaks were recorded during every follow –up visit

RESULTS

From March 2014 to September 2016, 5 patients underwent parallel endograft endovascular aneurysm repair (PG-EVAR) for infra-renal abdominal aortic aneurysms associated with unilateral or bilateral common iliac with or without hypogastric artery aneurysms. Four patients were male (80%), presenting a median age of 77 years (range 66-88 years). Co-morbidities presented in Table 1 and were typical for these high-risk patients.

Table 1: Patient's characteristics and pre-operative associated co-morbidities

Variable	*No. of patients*
Demographics	
Age (years)	77 yrs (range 66-88 years)
Sex (male)	4
Risk factors	
Hypertension	2
hyperlipidemia	1
Diabetes mellitus	4
Active smokers	4
Preoperative co-morbidities	
Cardiac diseases	3
Previous myocardial infarction	1
PTCA+ stent	2
Ejection fraction <35%	1
COPD	3
ASA III	4
ASA IV	1

COPD: chronic obstructive pulmonary disease; PTCA: percutaneous transluminal coronary angioplasty

All patients had infrarenal AAA with median diameter of 67 associated with unilateral CIA aneurysm in 4 cases and one case with bilateral CIA aneurysms associated with bilateral hypogastric artery aneurysms.

All patients underwent general anesthesia. All the procedures were technically successful with aneurysms exclusion and patent internal and external iliac artery grafts. The median length of the procedure was 105 minutes (80-210 minutes), fluoroscopy time (15-50 minutes), IV contrast dose 85 mL (50-180 mL), and average estimated blood loss 55 mL (30-400 mL). A total of 6 self expanding covered stents (4 Fluency stents & 2 Viabhan stents) were used with 6 SMART Control (Cordis, J&J Medical, Miami, FL) self-expanding bare-metal stents for their relining. One patient presented with immediate post-operative right arm weakness due to cerebral infarction and was managed conservatively and regained good functional recovery. Another patient developed postoperative severe respiratory insufficiency due to severe chronic obstructive pulmonary disease requiring ICU admission for 20 days for its management. The overall hospital stay was at a median of 3 days (2-20 days). No type I or III endoleaks were detected. Mild aneurysmal sac enlargement occurred in one case only at follow up CT due to persistent type II endoleak. One patient died at 10 months post intervention due to extensive myocardial infarction. Follow-up CT and Duplex scans showed patency of all Viabhan and Fluency grafts at a median follow-up of 6 months (range 3-10 months).

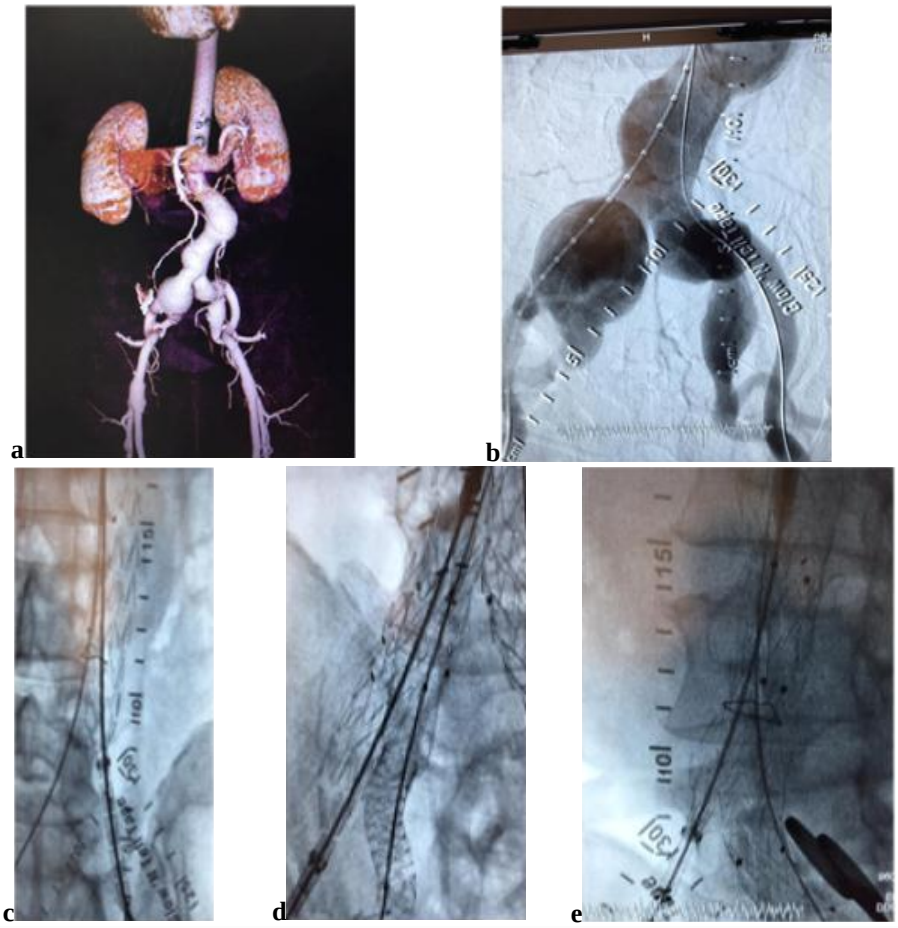

Fig. 1: sandwich technique for AAA associated with bilateral CIA aneurysm and bilateral HGA aneurysm **A & B**: pre-operative CT-angiography of an abdominal aortic aneurysm with bilateral CIA aneurysms and HGA aneurysm. **C**: deployment of the main body stent graft with landing on the proximal ipsilateral CIA proximal to the iliac bifurcation. **D**: the parallel grafts in place after deployment of both the Fluency graft and the ipsilateral ILE. **E**: deployment of the contralateral iliac limb

DISCUSSION

The treatment of abdominal aortic aneurysms (AAAs) has undergone dramatic shift over the last 20 years with the advent of endovascular techniques. Endovascular aneurysm repair (EVAR) for both elective and ruptured AAAs has decreased peri-operative morbidity and mortality as well as length of hospital stays. It has been accepted particularly for high-risk patients who would not be able to tolerate or survive conventional open repair, however it is also widely used for standard-risk AAA patients[1]. Despite the success of endovascular techniques, one aspect of aneurysaml disease that continues to be troublesome is the management of associated iliac aneurysms and the possible clinical significance of sacrificing the hypogastric arteries (HGAs) for effective treatment. Up to 20-30% of AAAs has concomitant common iliac artery aneurysms [1] and in these cases, total endovascular aneurysm exclusion can be difficult because of the need for adequate distal landing zones to prevent type Ib and type III endoleaks. However, it is still prudent and in line with basic tenets of endovascular technique to ensure proper distal coverage, which in some cases may require converge of either one or both HGAs ostium.

Several studies have shown that HGA occlusion can be performed without significant life-threatening pelvic ischemic complications.[15] Mehta et al. outlined the possible consequences of HGA occlusion, both via endovascular and open approaches, and found them to be of low incidence and morbidity. They reported no cases of buttock gangrene, ischemic colitis requiring surgical exploration, or any deaths associated with either unilateral or bilateral HGA occlusion.[16, 17] Zander et al. also noted acceptable rates of pelvic ischemic complications following bilateral HGA occlusion with only one of the 14 patients in the study suffered from persistent symptoms of buttock claudication that resolved completely within 18 months [18]. Although the majority of the complications following HGA occlusion either unilateral or bilateral are not life-threatening, other complications have been well documented especially erectile dysfunctions[18]. The most common pelvic ischemic complication is buttock claudication with incidences ranging from 1.6% to 56%.[19] In a literature review by Lin et al.,[19] about hypogastric artery (HGA) embolization during EVAR looking at peer-reviewed 21 published reports, the incidence of buttock claudication was 28% for unilateral embolization and 42% for bilateral embolization. Those who underwent unilateral HGA embolization were better able to tolerate their buttock symptoms and had higher rates of resolution without the need for further intervention but in 9-15% of patients persistent symptoms at 1 year have been observed.[19, 20, 21] another feared pelvic ischemic complication of HGA occlusion is colonic ischemia with a 9% incidence [22, 23] During EVAR, the inferior mesenteric artery is routinely sacrificed, and therefore embolization of one or both HGAs can have bad consequences on the blood supply of the distal and sigmoid colon due to loss of the collateral circulation. This is especially important in patients with previous colonic surgery when the inferior mesenteric artery is sacrificed proximal to the origin of the left colic artery making blood supply unpredictable and likely diminished resulting in a theoretical increased risk of this complication. Most patients found to have colon ischemia, however, can be managed non-surgically with close observation, antibiotics, and a short period of bowel rest [22]. New onset erectile dysfunction has been found to occur in up to 33% (10 - 45%) of patients undergoing HGA occlusion.[7, 22] Lin et al. demonstrated a significant decrease in penile pressure after bilateral HGA embolization[19]. Although not a life-threatening consequence of HGA occlusion, this complication is considered by some patients to be quite problematic to their overall quality of life and satisfaction, especially in the 15% of patients who suffer from persistence of this symptoms.[23-25] Other rare, but devastating complications following HGA occlusion include spinal cord ischemia, buttock necrosis, scrotal skin ulceration, and sciatic nerve ischemia.[24-26] For those patients undergoing HGA occlusion, the risk of complications can be compounded by severe atherosclerotic disease of the contralateral HGA, the ipsilateral femoral circulation, especially the deep femoral artery, and/or the presence of a large inferior mesenteric artery [26]. Prior thoracic aneurysm repair may also have bad consequences on spinal cord blood flow [26]. Eagleton et al. in a recent review showed that extensive endovascular procedures, particularly concomitant thoracic aneurysm repair are commonly associated with higher rates of spinal cord ischemia, even when only single collateral was occluded. In those cases, outcomes were found poor and mortality rates were significantly higher[27]. Other risk factors that may affect the outcomes include young age and left ventricular dysfunction.[28-29] These factors should be taken into consideration when planning for the aneurysm repair and whether to sacrifice or preserve the HGA (table 2)

Table 2: Factors determining the need for hypogastric artery preservation during EVAR [29]

Relative indications for HGA preservation
Young age
Left ventricular dysfunction
Previous colonic resection
Presence of thoracic aortic aneurysm
Severe superior mesenteric artery, ipsilateral femoral or
contra lateral HGA disease
Large inferior mesenteric artery

Thus, despite previously mentioned studies supporting HGA occlusion as a relatively benign procedure, it is well documented that pelvic

ischemic complications do occur and can affect overall quality of life. Therefore, attempts at preserving the HGA should be employed in selected patients when technically feasible.[30] Open surgical methods include external iliac artery to HGA bypass, transposition of the HGA to the external iliac artery, as well as hybrid techniques utilizing an aortouniiliac stent graft with femoro-femoral bypass [5]. These procedures usually subject the patient to general anesthesia and the morbidities associated with open vascular surgery including bleeding, infection, and other less common but significant complications [5]. Alternatively, an endovascular approach to HGA preservation may be associated with decreased morbidity and mortality, and overall length of hospital stay as compared with open procedures. They do, however, prolong the EVAR procedure and expose the patient to larger contrast and radiation doses [3].

The sandwich technique is a creative method to expand EVAR feasibility in the setting of adverse or challenging iliac artery anatomy. Its main advantages include no restrictions in terms of CIA diameter or length or HGA diameter.[8] Cannulating the HGA from the brachial artery and advancing an endograft from the upper extremity is not generally technically challenging. Sealing the commissural angles is apparently achievable, because oversizing the limbs and endograft in relation to the diameter of the main graft will produce a tight apposition of the components.[31] So far, there have been only a small number of case reports on the sandwich technique for preserving HGA blood flow with no significant complications have been associated with all the reported data on technical success and the excellent short and mid-term outcomes.[32-34] Ricci et al., found that the sandwich stent graft remained patent after 1-year follow-up [35]. Endovascular management of AAA involving CIA can be done using a branched stent graft which can be customized to each patient's iliac artery anatomy. Currently, branched stent grafts are not commercially available in Egypt. By contrast, the sandwich technique does not require waiting for a specific stent graft. On the other hand, there are also disadvantages of the sandwich technique as have been demonstrated by Ricci et al.,: 1) it requires an access from the brachial artery in addition to the femoral arteries accesses; 2) Viabhan stent grafts are generally not much radiopaque so that positioning them requires extra experience; 3) the use of the self-expanding stent graft for the sandwich technique is limited by its available sizes (size range, 9-13 mm in diameter) 4) furthermore, a bailout technique needs to be developed for cases of peri-graft leaks [35]

The parallel endografts in PG-EVAR (Parallel Graft-Endo Vascular Aneurysm Repair) present identical proximal diameters and neither space competition nor graft in-folding is created as in the case of a main body endograft with smaller chimney grafts to visceral and/or renal vessels. Post stent deployment compliant balloon dilation has the value of effectively adjusting ILEs on the endoluminal aortic surface. In all cases perfect adaptation of the two stents to the aortic wall was observed after molding, even if the planned oversizing was more than what was commonly done (about 35-40%) in some cases. In our opinion, the standard concept of proximal neck oversizing in these cases cannot be compared to the oversizing used for the main body endograft of a standard EVAR. Moreover, when one HGA was targeted the covered stent-grafts were first delivered and naturally engaged the space between the ILEs which were subsequently released in the proximal landing zone. Therefore, the molding of endografts is distributed between the two ILEs and the risk of type Ia endoleak from gutters minimized. The median time of the procedure (105 min), volume of estimated blood loss (55 mL), volume of contrast used (85 mL), and radiation exposure time (25 min) demonstrate that PG-EVAR is a straightforward and safe technique. One patient in this study developed a post-operative ischemic stroke in the cerebral area of the left carotid artery. Ischemic stroke in the left carotid cerebral area could happen from wire manipulation across the aortic arch, but it is also possible to result from distal femoral accesses [36].

Stroke complications are reported during chimney graft EVAR and represent a limitation of the procedure. In the meta-analysis presented by Moulakakis et al., 3.2 % of patients developed ischemic stroke [36]. The new currently available devices with low profile delivery sheaths should help to reduce these complications. No type Ia endoleak was observed postoperatively or during the median 6 (3-10) months of follow-up. Aneurysm shrinkage of about 10 mm was observed in all patients except one who developed

a slight increase in sac diameter (5 mm) due to a persistent type II endoleak after 5 months. A closer follow-up with possible secondary intervention was planned but unfortunately the patient died from unrelated causes after 8 months. The main limitation of the present study is that it is neither a randomized nor a controlled trial with any comparisons and results should be interpreted cautiously. The small number of expected patients would have made any statistically significant conclusion difficult to reach with any possible control group. The median aortic aneurysm diameter was small (67 mm). Viabahn grafts and targeted IIAs were patent in all patients without any sign of stenosis or pelvic ischemia at the end of a median follow-up of 6 (3-10) months.

CONCLUSION

In conclusion, our limited series indicates that the sandwich technique is a technically safe and effective technique for the preservation of HGA circulation. In our opinion, it has the advantage of expanding the applicability of EVAR for AAA with complex iliac artery anatomies. However, further studies with more long-term data are required to confirm the safety and efficacy of the sandwich technique.

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