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# Outcomes of Endovascular Repair of Aorto-iliac Aneurysms and Analyses of Anatomic Suitability for Internal Iliac Artery Preserving Devices in Japanese Patients

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## Abstract

**Background—**Understanding common iliac arteries (CIA) are shorter in Asian patients, we investigated whether this anatomical difference affects clinical outcomes of internal iliac artery (IIA) exclusion during endovascular repair (EVAR) of aorto-iliac aneurysm and limits the use of IIA preserving devices in Japanese patients.

**Methods and Results—**From 2008–2014, 69 Japanese patients underwent EVAR of aorto-iliac aneurysms with 53 unilateral and 16 bilateral IIA exclusion. One patient had persistent-buttock claudication during follow-up; however colonic or spinal cord ischemia was not observed. Anatomic suitability was investigated for the iliac branch device (IBD) by Cook Medical and iliac branch endoprosthesis (IBE) by WL Gore. Eighty-seven aorto-iliac segments were analyzed: 17% meet criteria for the IBD and 25% meet criteria for the IBE with 40% meeting criteria for either. Main exclusions for the IBD were IIA diameter >9 mm or <6 mm, (47%) and CIA length <50 mm, (39%). Main exclusions for the IBE were proximal CIA diameter <17 mm, (44%) and aorto-iliac length <165 mm, (24%).

**Conclusions—**EVAR with IIA exclusions in Japanese patients showed low incidence of persistent-buttock claudication and no major pelvic complications. Aorto-iliac morphology demonstrated smaller proximal CIA diameters and shorter CIA lengths, limiting the use of IIA preserving devices.

### Keywords

aorto-iliac aneurysm; anatomic ethnic differences

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## Introduction

In 2004, Chang and colleagues first reported Asian patients with abdominal aortic aneurysms (AAA) have shorter common iliac arteries (CIA) compared to published literature.[1] Their findings found an average right and left CIA length of artery of 29.9 mm and 34.2 mm, respectively; and an aorto-iliac length 20 mm shorter than previously noted. Their work also found 51% of the internal iliac artery (IIA) coverage was necessary for endovascular aneurysm repair (EVAR) with stent technology during that period. As traditional EVAR devices requires distal fixation in the common iliac artery, anatomic constraints such as short CIA length and aneurysmal dilation preclude successful distal fixation and effective seal.[2] Previous studies have shown that 15–40% of patients undergoing evaluation for AAA repair have unilateral or bilateral CIAs.[3–11] Challenging iliac anatomy can be treated with graft extension into the external iliac artery at the expense of excluding the IIA with the possibility of pelvic ischemia. Exclusion of the IIA can lead to a wide range of complications that are difficult to predict from early buttock claudication to the more devastating colon and spinal cord ischemia.[12]

To preserve pelvic circulation "branched limbs" or "branched devices" designed with an IIA stent have undergone multiple design revisions to minimize complications and suit a higher number of patient anatomy.[13] The Cook (Bloomington, IN) Iliac Branch Device (IBD) device underwent multiple revisions to design and has been approved CE-marked in Europe in 2006 and 2008.[14,15] The WL Gore (Flagstaff, Ax) Iliac Branch Endoprosthesis (IBE) has been approved in Europe in November 2013 and March 2016 in the United States.[16,17] As these devices are not currently approved in Japan we investigated whether these off the shelf devices would be suitable in Japanese patients according to the instruction for use (IFU) guidelines. We also report our clinical outcomes of EVAR of aorto-iliac aneurysm with IIA exclusion.

## Methods

We retrospectively reviewed all patients undergoing endovascular repair of aorto-iliac aneurysm, defined as dilation of the infrarenal aorta and/or CIA 1.5 times the normal size, at a single Japanese academic institution from January 2008 to December 2014. This study was approved by the institutions' IRBs. This study included patients who underwent EVAR with at least one aneurysmal CIA. Open procedures and patients undergoing repair for aneurysm rupture, pseudoaneurysm, or mycotic aneurysm were excluded from the study. Peri-operative records including patient demographics and intra-operative details were noted. Patients were noted to have either an endovascular repair with either bilateral or unilateral IIA exclusion. Technical success was defined as exclusion of the aneurysm without type 1 or type 3 endoleaks on completion angiogram.

Patient records were investigated regarding re-intervention, major adverse events (MAE) and aneurysm related death. Endoleak occurrence and endoleak type were noted on follow-up imaging. Symptoms related to IIA exclusion i.e. buttock claudication, colonic ischemia, and spinal cord ischemia were investigated. Buttock claudication symptoms were noted according to walking distance, and patients were followed to observe if there was a resolution of symptoms. Phone interviews were conducted as necessary to supplement clinic visit information.

Pre-operative aorto-iliac imaging data was reviewed on a 3-D workstation using Zio station 2 software (Ziosoft, Tokyo, Japan). Briefly, centerlines of flow were created from reconstructed CT studies and aorto-iliac lengths and diameters were measured. Inclusion and exclusion criteria of the iliac branch system from Cook Medical and WL Gore were investigated. For the Cook IBD, exclusion criteria included: CIA Length < 50 mm, CIA Diameter < 20 mm, external iliac artery (EIA) Length < 20 mm, EIA diameter < 8 mm, IIA occluded or 50% stenosis, IIA aneurysm distal to landing zone, IIA length < 10 mm, IIA diameter < 6 or > 9 mm. For the Gore IBE the exclusion criteria were noted as: Aorto-iliac length < 165 mm, CIA diameter < 25 mm, proximal CIA diameter < 17 mm, Distal CIA diameter < 14 mm, EIA Length < 10 mm, EIA diameter <6.5 or > 25 mm, IIA length < 10 mm, IIA diameter < 6.5 or > 13.5 mm. The aorto-iliac length is defined as the distance from the lowest renal artery to the IIA bifurcation. The IIA landing measurements were performed on the IIA segment before a first order branch without aneurysmal dilation or stenotic lesions suitable for stent graft placement. Previously published data at American institutions[18] were used to compare aorto-iliac aneurysm morphology in the current study.

Descriptive statistics were performed using Microsoft Excel (Bellvue, WA). Differences in outcomes regarding patients undergoing bilateral and unilateral IIA exclusion were evaluated using a t-test for continuous variables and Chi-squared test or Fischer Exact test for categorical values.

## Results

A total of 69 Japanese patients underwent EVAR with involvement of at least one CIA aneurysm during the study period. The mean age of the patients was 73.1 years old and 93% were male. There were 53 patients that underwent unilateral IIA exclusion and 16 patients with bilateral IIA exclusion. Patient demographics for bilateral or unilateral IIA exclusion are noted in Table 1. The mean height, weight and BMI of the patients were 1.66 m (range 1.41 – 1.82), 64.1 kg (range 40–93), and 23.3 m/kg$^2$ (range 16 –31), respectively. Coronary artery disease (CAD) was higher in the unilateral group compared to the bilateral IIA exclusion group (43% vs 13%, P=0.036) and was the only co-morbidity with statistical significance.

Operative details regarding the technique for IIA exclusion are noted in Table 2. Staged procedures were performed in 36 patients (52%) to exclude the IIA with the coil and coverage technique.[19] All patients underwent exclusion of the IIA using this technique except for one open ligation of the IIA.

Technical success of endovascular repair of the aorto-iliac aneurysm was 100% in the 69 patients. The operative time for unilateral repair (201 ± 82 min) was shorter compared to bilateral repair (327 ± 156, P=0.006). One intra-operative complication of limb thrombosis was observed, which was treated successfully with aspiration and additional stent graft placement. No intra-operative deaths occurred. There were 2 peri-operative MAEs in the follow-up period with one common femoral artery occlusion due to flap occlusion at the femoral access site requiring flap fixation on the day of the operation and one type B Dissection with abdominal pain occurring one day after the initial operation, which was treated conservatively with blood pressure control.

Median follow-up was 39.8 months (interquartile range 24.1–59.7) and procedure related complications are reported in Table 3. Regarding complications from IIA exclusion, no events of colonic or spinal cord ischemia were observed. Early buttock claudication was observed in 23 occurrences with 30% occurring in the unilateral group compared to 44% in the bilateral exclusion group, P=0.354. There was only one occurrence of persistent buttock claudication in the bilateral IIA exclusion group. The incidence of early buttock claudication was similar when excluding the IIA in a staged procedure (13/36 – 36%) compared to EVAR with IIA exclusion during a single procedure (10/33 – 30% P=0.806). Analysis of the bilateral IIA exclusion group, showed a higher incidence of early buttock with a staged procedure (6/7 – 86%) compared to single procedure (1/9 – 11%, P= 0.009).

Twenty post-operative endoleaks were observed in 18 patients with the details noted in Table 3. Four of the 23 patients with early buttock claudication had type 2 endoleaks (17%) compared to 14 patients with endoleaks without buttock claudication (30%, P=0.384). Five late aneurysm related complications were found in the unilateral IIA exclusion group: two expanding aorto-iliac aneurysms >5 mm, one type 1 endoleak, one left limb occlusion, and one right limb occlusion. Five secondary interventions were performed at an average of 21.5 months after initial operation (range 2–41 months) which included: left stent graft extension, coiling for type 2 endoleak, proximal extension cuff, femoral bypass, and thrombectomy with stent insertion.

The anatomical characteristics of the aorto-iliac aneurysm are noted in Table 4. The average infrarenal aortic length (125.1 ±19.6 mm) and CIA length (56.5 ± 20.2 mm) were similar between the two groups. However, the aorto-iliac length was found to be longer in the bilateral IIA aneurysm group (189.6 ± 34.3 mm) compared to the unilateral IIA group (177.5 ± 22.2, P=0.05). The IIA length was longer for the bilateral IIA group (56.4 ± 25.7 mm) compared to the unilateral group (46.8 ± 14.0, P= 0.028); however, the landing length was found to be shorter in the bilateral group (19.6 ± 16.2 mm) compared to the unilateral group (34.0 ± 16.0, P<0.001). CIA and EIA diameters were similar between the two groups; however, the IIA diameters were larger in the bilateral IIA exclusion group.

Suitability of the 87 aneurysmal CIA segments for IIA preserving devices are noted in Table 5. Of note there were 58 CIA segments that were analyzed in the 53 unilateral IIA exclusion group as 5 bilateral CIA aneurysms were treated with a traditional or bell-bottom limb on the non-excluded IIA side. There were 29 CIA segments analyzed in the 16 bilateral IIA exclusion group as there was one instance of a chronic external iliac occlusion leading to aorto-uni-iliac repair, one instance of a chronically occluded IIA, and one instance of IIA aneurysm requiring coiling in a non-aneurysmal CIA segment. Of the 87 CIA segments, 15 (17%) met criteria for the IBD and 22 (25%) met criteria for the IBE, with 35 (40%) meeting criteria for either. The main exclusions for the Cook IBD were the IIA diameter being >9 mm or <6 mm, n = 41 (47%); the length of the CIA being <50 mm, n= 34 (39%);

and the EIA diameter being < 8 mm, n = 32 (37%). The main exclusions for the Gore IBE were proximal CIA diameter <17 mm, n = 39 (44%) and aorto-iliac length <165 mm, n = 21 (24%).

Overall CIA lengths were shorter for Japanese patients compared to American patients previously reported[18] but overall aorto-iliac lengths were similar: 56.5 ± 20.2 mm vs. 71.4 ± 23.7 (P < 0.001), 181.6 ± 27.5 mm vs. 183.6 ± 28.3 (P= 0.584), respectively. Regarding the 29 CIA segments in the 16 patients with bilateral IIA exclusion, 5 segments (17%) met IFU criteria for the Cook IBD and 8 (28%) segments met IFU criteria for the Gore IBE.

## Discussion

In 2009, Verzini and colleagues reported their results of IIA exclusion versus IIA preservation with the Cook IBD.[20] Their study showed a lower frequency of iliac endoleaks (4 vs. 19%, P=0.07) and buttock claudication (4% vs. 22%, P=0.1) for the IIA preservation group compared to the IIA exclusion group. This study concluded that IIA preservation should be considered in younger, active patients with suitable anatomy. Multiple other studies have confirmed high technical success using IIA preserving devices with a low frequency of pelvic ischemia.[21] However, these grafts are not available throughout the world and studies to determine the anatomic suitability and clinical outcomes according to ethnicity are limited.

Our study shows the rate of early buttock claudication in Japanese patients undergoing EVAR for aorto-iliac aneurysm with IIA exclusion was 33%. All but one patient had resolution of their symptoms and there were no major complications of colonic or spinal cord ischemia. Overall, our findings of early buttock claudication are consistent with published literature occurring 1.6–56% with IIA exclusion. However, our low rate of persistent buttock claudication (6%) is lower than previously noted occurrence of 10–45%.[12] The reasons for this are unknown, but may be explained by a lower clotting profile in Japanese patients and a difference response to anti-coagulation therapy.[22,23] Type II endoleaks which are reported to be as high as 28% in Japanese patients[24] was not found to be protective of buttock claudication in our study.

There were a higher frequency of patients with buttock claudication with bilateral IIA exclusion (44%) versus unilateral exclusion (30%); however, this was not statistically significant. A previous systemic review by Raya et al showed similar rates of buttock claudication and sexual dysfunction in unilateral and bilateral IIA exclusion demonstrating the difficulty in predicting which patients are at risk.[25] CAD which was found to be significantly lower frequency in the bilateral exclusion IIA group may have contributed to similar results due to ventricular dysfunction being a pre-operative risk factors of pelvic ischemia.[26] Complications with bilateral IIA exclusion may be mitigated using a staged procedure or possible proximal iliac artery occlusion allowing distal collateral arteries to provide pelvic ciculation.[27–29] However, our series showed that there was a higher incidence of early buttock claudication in the bilateral IIA exclusion group when a staged procedure was performed. This may be due to embolization of distal arteries during the initial procedure. Currently, no consensus statement is made regarding staged procedure or necessity for IIA preservation.[2]

Re-interventions for IIA exclusion is reported to be 5–14.5%.[20,30] In our series, there were 5 re-interventions (7%) during follow-up. There were no re-interventions for the bilateral IIA exclusion group. In the study by Verzini and colleagues the re-intervention rate was higher in the IBD group (16%) compared to IIA exclusion group (6%); however there were more type II endoleaks in the IIA exclusion group.[20] The 5-year Cook IBD re-intervention rates were 20% with iliac limb occlusion occurring in approximately 10% of patients.[31]

This leads to the discussion of the cost of the endovascular repair between IIA exclusion and IIA preservation. As branch devices cost approximately 9000 US dollars, not including the extension IIA stent, there may not be strong financial advantages for placing these branched devices in Japanese patients given the low rates of pelvic ischemic complications and lower intervention rates. Micro coils cost approximately 3500 US dollars per occluded artery, but may be replaced with cheaper vascular plugs[32] or even 0.035 inch coils. Although major complications of colonic and spinal cord ischemia were not encountered in this study, these scenarios can have significant long-term patient morbidity and needs to be evaluated further. This study did not evaluate sexual dysfunction which also leads to increased morbidity and associated costs. As sexual dysfunction is not routinely evaluated in patients over 70 years of age at the study institution this is a limitation of the study.

Our anatomic analysis of aorto-iliac aneurysm showed an average CIA length of 56.5 mm which is longer than previously reported length by Chang et al in AAA patients (29.2–34.2mm), but shorter than published literature of aneurysms of the CIA (64.6 – 85 mm).[18,33–35] Although Asian patients were found to have a shorter non-aneurysmal CIA compared to the literature when the CIA becomes aneurysmal it also lengthens. When comparing the aorto-iliac length we found that Japanese patients had similar lengths (181.6 ± 27.5 mm) compared to patients treated in America (183.6 ± 28.3 mm) which is somewhat surprising given Japanese patients are noted to be of a shorter average height.[36,37] Previous morphologic analysis of AAA without iliac aneurysms in Japanese patients found the average aorto-iliac length to be 147.6 mm.[38] This difference is likely explained by the iliac length elongating and becoming more tortuous with aneurysmal degeneration. Masuda and colleagues previously described higher iliac tortuosity in Asian patients treated with EVAR in the United States.[39] The study also highlighted smaller EIA diameter in Asian patients (8.2 ± 1.1 mm) undergoing EVAR for AAA which was associated with endovascular access complications. Our study also found small EIA diameters (8.1± 1.5 mm), consistent with reported literature,[38] which limit IIA preserving device suitability.

Our study also demonstrated larger IIA diameters as well as distal CIA diameters in the bilateral IIA exclusion group compared to the unilateral group. This finding shows aneurysm distribution becomes more diffuse and extends to the IIA when bilateral CIA aneurysms are present. Although there were higher aneurysmal dilation of the IIA in the bilateral group this alone did not exclude the limbs from the IIA preserving devices compared to the unilateral group.

The number of patients that were able to be treated with IIA preserving branch devices based on anatomic criteria was 15 (17%) for the Cook device and 22 (25%) for the Gore device, with 35 (40%) meeting criteria for either. The main exclusion for the Cook IBD is an IIA diameter of < 6 mm of > 9 mm which excluded 41/87 (47%) segments in our study. Updated guidelines for the Cook IBD trial in mid-2014 increased the IIA diameter to 10 mm which would exclude 27/87 (31%) segments in our study increasing overall inclusion percentage from 17% to 22%. Other reasons for exclusion are based on the inherit device designs. The Cook IBD incorporates a branch limb off an iliac limb requiring a longer CIA segment and larger EIA diameter; whereas the IBE uses a short, narrow EVAR device to deploy above the iliac bifurcation thereby requiring a proximal CIA diameter > 17 mm and an aorto-iliac length to be > 165 mm. Our series showed similar percentages for inclusion for the Cook IBD (18–33%) and Gore IBE (23%)[18,35,40]. However, institutions and operators have successfully deployed these devices outside of the IFU according to institutional protocol.[35] As overall inclusion percentages were similar in this Japanese study compared to global studies, this supports multi-national clinical trials to evaluate new stent design, such as was done for drug eluting technology in peripheral arterial disease patients.[41]

A small series of IIA preserving devices have successfully been deployed in Japanese patients with bilateral CIAs.[42] The reported technical success rate was high and there were minimal short-term complications. Whether it will be cost effective to implant future IIA preserving devices in Japanese patients deserves further investigation. Individual patient presentation such as age, cardiac status, previous colonic resection, and possible thoraco-abdominal aneurysms as well as operator experience need to be considered in treatment choice in preserving IIA flow.

## Conclusions

No major pelvic complications were observed in our series of patients with IIA exclusion during endovascular repair of aorto-iliac aneurysms. Early buttock claudication was seen with rates similar to previous studies while long term buttock claudication is lower than published literature. Analysis of aorto-iliac morphology showed a smaller diameter of the proximal CIA and shorter CIA lengths. However, aorto-iliac lengths are similar between Japanese patients and patients treated in the United States, which may be due to aortic elongation and increased tortuosity in Japanese patients. Although similar percentages of aorto-iliac segment in Japanese patients were suitable for IIA preserving devices within the IFU, ethnic differences in aorto-iliac anatomy may warrant future sent design consideration.

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## Table 1

Patient Demographics

| | Total (n=69) | Unilateral (n = 53) | Bilateral (n=16) | P-value |
|---|---|---|---|---|
| Age (year)° | 73.1 (8.8) | 73.3 (9.2) | 72.4 (7.7) | 0.724 |
| Male Gender (%) | 65 (93) | 49 (91) | 16 (100) | 0.566 |
| Height (m)° | 1.66 (0.07) | 1.65 (0.07) | 1.67 (0.07) | 0.456 |
| Weight (kg)° | 64.1 (9.1) | 63.16 (11.8) | 64.4 (8.3) | 0.962 |
| BMI ($kg/m^2$)° | 23.3 (2.7) | 22.7 (2.7) | 23.5 (2.7) | 0.420 |
| HTN (%) | 55 (80) | 41 (77) | 14 (88) | 0.494 |
| DM (%) | 5 (7) | 5 (9) | 0 (0) | 0.583 |
| CAD (%) | 25 (36) | 23 (43) | 2 (13) | 0.036 |
| CVD (%) | 8 (12) | 8 (15) | 0 (0) | 0.183 |
| CHF (%) | 5 (6) | 4 (8) | 1 (6) | 1.000 |
| COPD (%) | 12 (17) | 11 (21) | 1 (6) | 0.270 |
| Pre-operative Cr (mg/dl)° | 1.02 (.37) | 1.00 (.41) | 1.08 (.36) | 0.503 |
| eGFR (ml/min)° | 59.8 (15.1) | 60.6 (15.1) | 57.3 (15.1) | 0.458 |
| Dialysis | 0 | 0 | 0 | N/A |
| Smoking (%) | 57 (83) | 46 (87) | 11 (69) | 0.132 |
| ASA score° | 1.49 (.61) | 1.45 (.62) | 1.63 (.61) | 0.337 |
| Anti-platelet (%) | 36 (52) | 31 (58) | 5 (31) | 0.565 |
| Anti-coagulation (%) | 11 (16) | 9 (17) | 2 (13) | 1.000 |

BMI - Body Mass Index, HTN - Hypertension, DM - Diabetes Mellitus, CAD - Coronary Artery Disease, CVD - Cerebral Vascular Disease, CHF - Congestive Heart Failure, COPD - Chronic Obstructive Pulmonary Disease, eGFR - estimated Glomerular Filtration Rate, ASA - American Society of Anesthesia

° Continuous data are shown as the mean (standard deviation)

## Table 2

Intra-operative Details

| | Total (n=69) | Unilateral (n=53) | Bilateral (n=16) | P-value |
|---|---|---|---|---|
| Staged Procedure (%) | 36 (52) | 29 (55) | 7 (44) | 0.570 |
| EVAR Device * | Ex - 27<br>Z - 19<br>En - 17<br>EPL - 6 | Ex - 15<br>Z - 17<br>En - 15<br>EPL - 6 | Ex - 12<br>Z - 2<br>En - 2 | |
| Operation Time ** (min) ° | 230 ± 116 | 201 ± 82 | 327 ± 156 | 0.006 |
| Blood Loss (ml) ° | 112 ± 196 | 87 ± 108 | 197 ± 353 | 0.238 |
| Intra-operative Complications | 1 | 1 - Embolization | 0 | 1.000 |
| Peri-operative MAE | 2 | 1 - CFA Occlusion | 1 - Type B Dissection | 0.413 |

* Ex – Gore Excluder Device, Z – Cook Zenith Device, En - Medtronic Endurant, EPL - Endologic Powerlink

** Does not included time of staged procedures

° Continuous data are shown as the mean ± standard deviation

## Table 3

Procedure Related Complications

| | Total (n=69) | Unilateral (n=53) | Bilateral (n=16) | P-value |
|---|---|---|---|---|
| Colon/ Spinal Cord Ischemia | 0 | 0 | 0 | N/A |
| Buttock Claudication - Early (%) | 23 (33) | 16 (30) | 7 (44) | 0.354 |
| Average Distance of Onset (m) ° | 485 ± 507 | 539 ± 539 | 364 ± 437 | 0.426 |
| Buttock Claudication - Persistent (%) | 1 (1) | 0 | 1 (6) | 0.232 |
| Number of patients with endoleaks (%) | 18 (26) | 16 (30) | 2 (13) | 0.206 |
| Description of endoleaks * | Type 1 −1<br>Type 2 – 19<br>Type 3 − 2 | Type 1 −1<br>Type 2 – 17<br>Type 3 − 2 | Type 2 - 2 | |
| Late Aneurysm Related Complications (%) | 5 (7) | 5 (9) | 0 | 0.583 |
| Number of Secondary Procedures (%) | 5 (7) | 5 (9) | 0 | 0.583 |

* Two patients had multiple types of endoleaks (Type 1&2, Type 2&3)

° Continuous data are shown as the mean ± standard deviation

## Table 4

Aorto-iliac measurements

| | Total (n=87) | Unilateral (n= 58) | Bilateral (n=29) | P-value |
|---|---|---|---|---|
| Infrarenal Aortic Length | 125.1 ± 19.6 | 122.8 ± 18.2 | 129.6 ± 21.4 | 0.125 |
| CIA Length | 56.5 ± 20.2 | 54.8 ± 16.0 | 60.0 ± 26.3 | 0.261 |
| Aorto-iliac Length | 181.6 ± 27.5 | 177.5 ± 22.2 | 189.6 ± 34.3 | 0.053 |
| IIA Length | 50.0 ± 19.3 | 46.8 ± 14.0 | 56.4 ± 25.7 | 0.028 |
| IIA Landing length | 29.2 ± 17.8 | 34.0 ± 16.0 | 19.6 ± 16.2 | <0.001 |
| Ao Max diameter | 37.9 ± 13.6 | 37.9 ± 14.3 | 37.8 ± 11.9 | 0.951 |
| Prox CIA diameter | 19.4 ± 7.7 | 18.3 ± 5.7 | 21.6 ± 10.2 | 0.057 |
| CIA Max diameter | 33.8 ± 9.5 | 32.6 ± 8.2 | 36.3 ± 11.2 | 0.080 |
| CIA Min diameter | 15.1 ± 3.9 | 14.6 ± 3.1 | 16.0 ± 4.9 | 0.111 |
| Distal CIA diameter | 20.8 ± 5.7 | 19.6 ± 5.4 | 23.2 ± 5.4 | 0.004 |
| IIA Max diameter | 17.2 ± 12.7 | 13.5 ± 8.2 | 24.4 ± 16.4 | <0.001 |
| IIA Min diameter | 8.2 ± 4.9 | 7.1 ± 2.6 | 10.3 ± 7.1 | 0.004 |
| IIA Landing diameter | 9.8 ± 4.8 | 8.7 ± 2.6 | 11.9 ± 6.8 | 0.002 |
| EIA Max diameter | 9.6 ± 1.5 | 9.5 ± 1.4 | 9.8 ± 1.7 | 0.279 |
| EIA Min diameter | 8.1 ± 1.5 | 8.0 ± 1.3 | 8.4 ± 1.8 | 0.234 |

Expressed in mean (mm) ± standard deviation

CIA - Common Iliac artery, IIA - Internal Iliac Artery, EIA - External Iliac artery

**Table 5**

Exclusion Criteria for IIA preserving devices in 87 aorto-iliac segments

| Cook IBD Exclusion Criteria | n (%) | Gore IBE Exclusion Criteria | n (%) |
|---|---|---|---|
| CIA length < 50 mm | 34 (39) | Aorto-iliac length < 165 mm | 21 (24) |
| CIA diameter < 20 mm | 2 (2) | CIA diameter < 25 mm | 5 (6) |
| EIA length < 20 mm | 8 (9) | Proximal CIA diameter < 17 mm | 39 (44) |
| EIA diameter < 8 mm | 32 (37) | Distal CIA diameter < 14 mm | 4 (5) |
| IIA occluded or 50% stenosis | 1 (1) | EIA Length < 10 mm | 6 (7) |
| IIA aneurysm distal to landing zone | 9 (10) | EIA diameter <6.5 or > 25 mm | 13 (15) |
| IIA length < 10 mm | 0 (0) | IIA length < 10 mm | 0(0) |
| IIA diameter < 6 or > 9 mm | 41 (47) | IIA diameter < 6.5 or > 13.5 mm | 13 (15) |
| Any Factor | 72 (83) | Any Factor | 65 (75) |

IBD - Iliac branch device, IBE - Iliac branch endoprosthesis