Challenging the Evidence for Pre-emptive Coil Embolisation of the Internal Iliac Artery during Endovascular Aneurysm Repair

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WHAT THIS PAPER ADDS

When coverage of the internal iliac artery (IIA) during endovascular aneurysm repair (EVAR) is required, it is common practice to perform adjunctive coil embolisation of the IIA. There is, however, no solid evidence for the necessity of this strategy. It has never been studied whether omission of coil embolisation leads to an increased risk of Type-II endoleak. This is the first study to describe the results of EVAR without pre-emptive IIA coiling in a consecutive series of patients with aortoiliac aneurysms.

Objectives: We retrospectively analysed the results of a strategy in which coverage of the internal iliac artery (IIA) during endovascular aneurysm repair (EVAR) was routinely performed without coil embolisation.

Methods: From January 2010 until May 2012, 32 patients (96.9% men; mean age 73.0 years, range 52—89 years) underwent EVAR with stent grafts extended into the external iliac artery (EIA), all without prior coil embolisation. Aneurysm morphology was determined on preoperative computed tomography (CT) images. During follow-up, patients were interviewed about buttock claudication, and the occurrence of endoleaks and evolution of aneurysm diameter were recorded.

Results: At baseline, the mid-common iliac artery (CIA) diameter was 33.5 ± 16.8 mm and seven patients presented with ruptured aneurysms. Mean follow-up was 14.3 ± 7.4 months. There were eight deaths, none related to IIA coverage. Buttock claudication occurred in seven (22.6%) patients, which persisted after 6 months in two cases of bilateral IIA coverage. No Type-I or -II endoleaks occurred related to IIA coverage. Aneurysm growth was not observed.

Conclusion: Endovascular treatment of aortoiliac and iliac aneurysm without pre-emptive coil embolisation of the IIA appears safe and effective. No IIA-related endoleaks or re-interventions occurred in our series. This approach saves operating time, contrast load and costs and may reduce complications. However, a larger population and longer follow-up is required to confirm our findings.

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Approximately 20—30% of abdominal aortic aneurysms (AAAs) involve at least one common iliac artery (CIA).[1] It has been demonstrated that the technical success rate of endovascular abdominal aneurysm repair (EVAR) is lower when a CIA is involved.[2] Whenever possible, the CIA will serve as a distal sealing site. Iliac limbs up to 28 mm diameter are commercially available for the so-called bell-bottom technique.[3] According to the manufacturers' instructions, these stent grafts may be used for iliac aneurysms up to 24 mm diameter, thereby avoiding coverage of the IIA. In cases of CIAs larger than 24 mm, however, extension of the stent graft into the external iliac artery (EIA) is often required to achieve adequate seal.[4] Alternatively, in elective cases with suitable anatomy, common iliac aneurysms may be treated with iliac branch devices or sandwich techniques in order to maintain inflow into the internal iliac artery (IIA).[5]

Theoretically, covering the IIA involves a risk of a Type-II endoleak. As a preventive measure, intentional IIA occlusion is assumed to be mandatory. Usually, IIA coil embolisation prior to EVAR is performed to prevent endoleak.[6,7] Less frequently, vascular plugs or acrylic glue are used, or

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intra-operative ligation, transposition or bypass of the IIA is applied.[8–11]

To date, however, no solid evidence exists for the necessity of these preventive measures. Previous studies focussed mainly on the outcome of coil embolisation itself.[12–18] Although most studies conclude that this method is relatively safe,[12,13,15,16,18] some serious complications have been reported, including gluteus muscle necrosis, ischaemic colitis and spinal ischaemia.[14–16,18–20] Complications are less frequent when IIA occlusion is performed more proximally to its orifice.[18] It has been hypothesised that sole stent-graft coverage of the IIA's orifice provides the most proximal occlusion and may limit the symptoms of pelvic ischaemia.[21,22] Remarkably, higher incidences of pelvic ischaemia are reported in endovascular series with IIA coverage than in open surgical series with IIA ligation.[15] This difference may partly be due to adjunctive measures such as coil embolisation of the IIA, leading to occlusion of secondary branches and interrupting pelvic collateral circulation.[11,18]

While recent studies have questioned the necessity and safety of coiling,[21–26] most reports of stent-graft coverage without coil embolisation have been limited to instances of unintentional coverage during stent deployment or to cases of technical failure of attempted coil embolisation.[21–25] Others applied this approach only in a selected group of patients.[26] Nonetheless, IIA-related endoleaks in these studies are rare, and none required secondary intervention.[21,25,26]

Since January 2010, a new policy has been applied in our department. None of the patients requiring EVAR with extension of a limb graft into the EIA were treated with preemptive coil embolisation. We analysed the technical and clinical outcomes of this new policy in a consecutive series of 32 patients, describing iliac configurations, aneurysm diameter, occurrence of Type-I and -II endoleaks and incidence of buttock claudication.

METHODS

Study population

From January 2010 to May 2012, all patients who were scheduled for EVAR with extension of a limb graft into the EIA were registered in a database and included in this study. In addition, we retrospectively reviewed procedural records of all EVAR procedures to identify and include cases in which inadvertent stent-graft coverage of the IIA had occurred.

Preoperative imaging

All patients underwent preoperative imaging of the abdomen and pelvis to evaluate morphological eligibility for endovascular treatment, and to determine the need for IIA coverage. The primary imaging modality was contrast-enhanced spiral computed tomography (CT) in conjunction with computer-aided measurements and central lumen line reconstruction (PACS Easy Vision, Philips Medical Systems BV, Eindhoven, The Netherlands). Vessel diameter was measured on CT scan reformats perpendicular to the artery. Maximum AAA and common iliac artery aneurysm (CIAA) diameters were recorded, as well as diameters of the most proximal and distal part of the CIA. Additionally, presence of flow in the proximal and distal branches of the IIA was registered. In cases of inadvertent coverage, missing variables were determined retrospectively.

Procedure

All endovascular procedures were performed in a vascular operating room under fluoroscopic control. A digital C-arm unit was used for making intra-operative angiograms (AXIOM Artis, Siemens AG, The Hague, The Netherlands). Anaesthetics, antibiotics and heparin were administered following standard regimen. Stent grafts used were Endurant (Medtronic AVE, Santa Rosa, CA, USA), Excluder (WL Gore Associates Inc., Flagstaff, AZ, USA) or Zenith (Cook Medical Inc., Bloomington, IN, USA). A completion angiogram with delayed series after aortic injection was obtained to detect the presence of endoleaks and to document the status of the covered IIA, the contralateral IIA and collateral vascularisation.

Follow-up

Patients were seen at 1, 6 and 12 months postoperative and after that once a year according to standard follow-up regimen. Consultations were conducted by senior vascular surgeons and included a patient interview, physical examinations and imaging studies. During the first year of follow-up, contrast-enhanced CT was used as standard imaging modality. After that, duplex ultrasonography was used. Experienced interventional radiologists and vascular surgeons assessed all images for aneurysm diameter increase or any signs of endoleaks.

During the follow-up, patients were specifically interviewed about the appearance or increase of pain in the hip or the buttock region. These symptoms were recorded as buttock claudication when they appeared immediately following EVAR and when the affected limb matched the side of IIA occlusion. Buttock claudication was categorised as severe if it interfered with daily activities and as mild if there was minor impact on lifestyle. Patients' files were reviewed for reports of adverse clinical events at follow-up to complete the database. If any uncertainty remained after file review, patients were interviewed by telephone. Occurrence of sexual dysfunction was not systematically included in the interview.

RESULTS

Baseline

From January 2010 to May 2012, 191 EVAR procedures were performed at our institution. Our study population consisted of a total of 32 (16.8%) consecutive patients, (31 men and one woman, mean age of 73.0 $\pm$ 8.9 years, range 52–89 years) who underwent an endovascular procedure with unilateral

IIA stent coverage (Table 1). Seven of these patients (21.9%) were operated in an emergency setting for aneurysm rupture. Indications for planned IIA coverage are shown in Table 2. In two cases of bilateral CIAAs, sole IIA coverage was performed at one side and an iliac-branched-device (Cook Zenith) was placed at the contralateral side. In another case, a planned bifurcated stent graft was converted into an aorto-uni-iliac (AUI) device due to severe tortuosity of one iliac artery. One IIA was intentionally stent covered, while the contralateral IIA remained patent with retrograde filling from a femoro-femoral crossover bypass. Furthermore, four cases of inadvertent IIA coverage were identified.

All patients had patent IIAs on preoperative computed tomography angiography (CTA), and none underwent any pre- or intra-operative intervention to occlude the IIA at the affected side. In two patients, however, the contralateral IIA had already been occluded for concomitant IIA aneurysm at another institution (Table 2). Both patients eventually had bilateral IIA coverage, but only the non-coiled IIAs were analysed. The anatomic configuration of the affected CIA was straight in three (9.4%) cases, balloon-shaped in 26 (81.3%) cases and funnel-shaped in three (9.4%) cases. In 19 (59.4%) cases, the right side was affected. Maximum CIA diameter in cases of CIA aneurysms ranged between 26 and 83 mm. The CIA diameter ranged between 10 and 39 mm at its most distal point, and between 6 and 20 mm at the orifice of the IIA (Table 1).

Table 1. Patient demographics, risk factors and baseline CIA morphology.

Variable	$N = 32$
Age (years)	
Mean ± SD	73.0 ± 8.9
Range	(52–89)
Male	31 (96.9%)
ASA classification	
Class I	0 (0.0%)
Class II	11 (34.4%)
Class III	9 (28.1%)
Class IV	5 (15.6%)
Class V	7 (21.9%)
Risk factors	
Smoking history	25 (78.1%)
Coronary artery disease	20 (62.5%)
Hypercholesterolaemia	19 (59.4%)
Hypertension	26 (81.3%)
COPD	8 (25.0%)
Arrhythmia	10 (31.3%)
Peripheral vascular disease	9 (28.1%)
Cerebrovascular disease	7 (21.9%)
Diabetes Mellitus	9 (28.1%)
Common iliac artery morphology	
Maximum CIA diameter (mm)	
Mean ± SD	33.5 ± 16.8
Range	(8–83)
Range (planned, $N = 28$)	(26–83)
Proximal CIA diameter (mm)	
Mean ± SD	17.8 ± 6.9
Range	(10–39)
Distal CIA diameter (mm)	
Mean ± SD	12.5 ± 4.0
Range	(6–20)
Anatomic configurations	
Straight	3 (9.4%)
Balloon-shaped	26 (81.3%)
Funnel-shaped	3 (9.4%)
Patency internal iliac artery	
Covered IIA patent	32 (100%)
Contralateral IIA patent	30 (93.8%)

ASA: American Society of Anaesthesiologists. COPD: chronic obstructive pulmonary disease.

Table 2. Indications for IIA coverage.

Indications for IIA coverage	Patients (N)
Elective cases (planned coverage)	
AAA with unilateral CIAA	9
AAA with left CIAA and right CIAA + IIAA[a]	1
CIAA (unilateral)	4
CIAA (bilateral)[b]	2
Limb extension after previous EVAR	5
Emergency cases (planned coverage)	
Ruptured AAA with unilateral CIAA	4
AAA with ruptured CIAA (unilateral)	1
Ruptured CIAA (unilateral)	2
Inadvertent coverage	
Isolated AAA	3
AAA with right CIAA + IIAA[c]	1

[a] Right IIAA was coil-embolised in another clinic. In our clinic bilateral IIA stent coverage was performed (left IIA included for analysis).

[b] Both cases had one IIA covered and received an IBD at the contralateral side.

[c] Right IIAA was coil-embolised. Intentional coverage of right IIA was performed. Left IIA was covered inadvertently (left IIA included for analysis).

Follow-up

No intra-operative deaths occurred, but one patient (rAAA case) deceased in the ICU several days postoperatively. This patient was not accounted for in further analysis, as the cause of death was not related to IIA coverage and no postoperative CTA was made. The remaining 31 (96.9%) patients had a mean follow-up of 14.3 ± 7.4 months (range 3–31 months). The number of patients who completed their 1, 6 and 12 months postoperative follow-up were 31, 28 and 21, respectively, with no cases lost to follow-up. Seven patients died during follow-up, but none of these deaths were related to the IIA coverage. At 3 months, two fatal myocardial infarctions occurred and one patient had multi-organ failure (MOF) after an intervention for a stomach bleeding. At 9 months, one patient died of MOF after an intervention for bilateral limb occlusion. Later on (at 16, 17 and 31 months post implant), three more patients died, of cancer, stroke and myocardial infarction, respectively.

Technical outcome

Coverage of the IIA's orifice with a stent graft that was 10% oversized relative to the EIA was achieved in all patients. The completion angiogram showed no signs of endoleak and more particularly no signs of Type-II endoleak due to

retrograde flow from the IIA. One-month CTA images and later imaging-studies demonstrated occlusion of the most proximal part of the IIA and absence of any IIA-related endoleaks (Fig. 1). Two cases of non-related endoleaks were seen on 1-month CTA images: a small Type-II endoleak originating from the inferior mesenteric artery (left untreated), and a large Type-I endoleak of the IBD (treated with extension of the IIA limb).

Increase of maximum AAA and CIAA diameters was not seen at any time point during follow-up. Furthermore, filling of distal branches of the affected IIA was observed in 20 (64.5%) patients. Notably, the AUI case with femoro-femoral cross-over showed bilateral filling of the distal IIA branches.

Clinical outcome

Seven (22.6%) patients reported symptoms of buttock claudication that appeared directly after the procedure. Of these cases, five were mild and two (6.5%) were severe. None of the patients had symptoms of hip or buttock claudication prior to the procedure.

Symptoms disappeared in four of the five mild cases within the first month post implant. In the fifth case, symptoms disappeared before the 6-month visit. The two patients with severe buttock claudication reported gradual improvement of symptoms over time, with persistent mild claudication at 12 and 18 months. These two patients were the ones with bilateral IIA occlusion. A review of their CT scans showed only marginal perfusion of the distal IIA at one side, and no significant flow at the contralateral side.

There was no incidence of ischaemic colitis, spinal cord ischaemia or gluteal necrosis. Sexual dysfunction, although not systematically asked for, was never reported. No additional secondary procedures were performed to secure IIA sealing or to improve pelvic perfusion in this cohort of AAA patients.

DISCUSSION

Pre-emptive coil embolisation is more or less standard practice in case the IIA is covered, even though no solid evidence is available on its necessity in terms of preventing Type-II endoleaks. To challenge this routine, we analysed a consecutive series of 32 patients after endovascular treatment of aortoiliac and CIA aneurysm without pre-emptive coil embolisation of the IIA. Our series did not indicate any short- or mid-term complications in terms of aneurysm growth or endoleaks. Our findings therefore suggest that endovascular treatment of aortoiliac and iliac aneurysms without coil embolisation of the IIA is safe and effective and that pre-emptive IIA coil embolisation may be redundant.

Several studies on preoperative coil embolisation of the lumbar arteries or inferior mesenteric artery failed to demonstrate any added value in terms of aneurysm growth or rupture.[27,28] There is no obvious reason why coil embolisation of the IIA would behave differently and would,

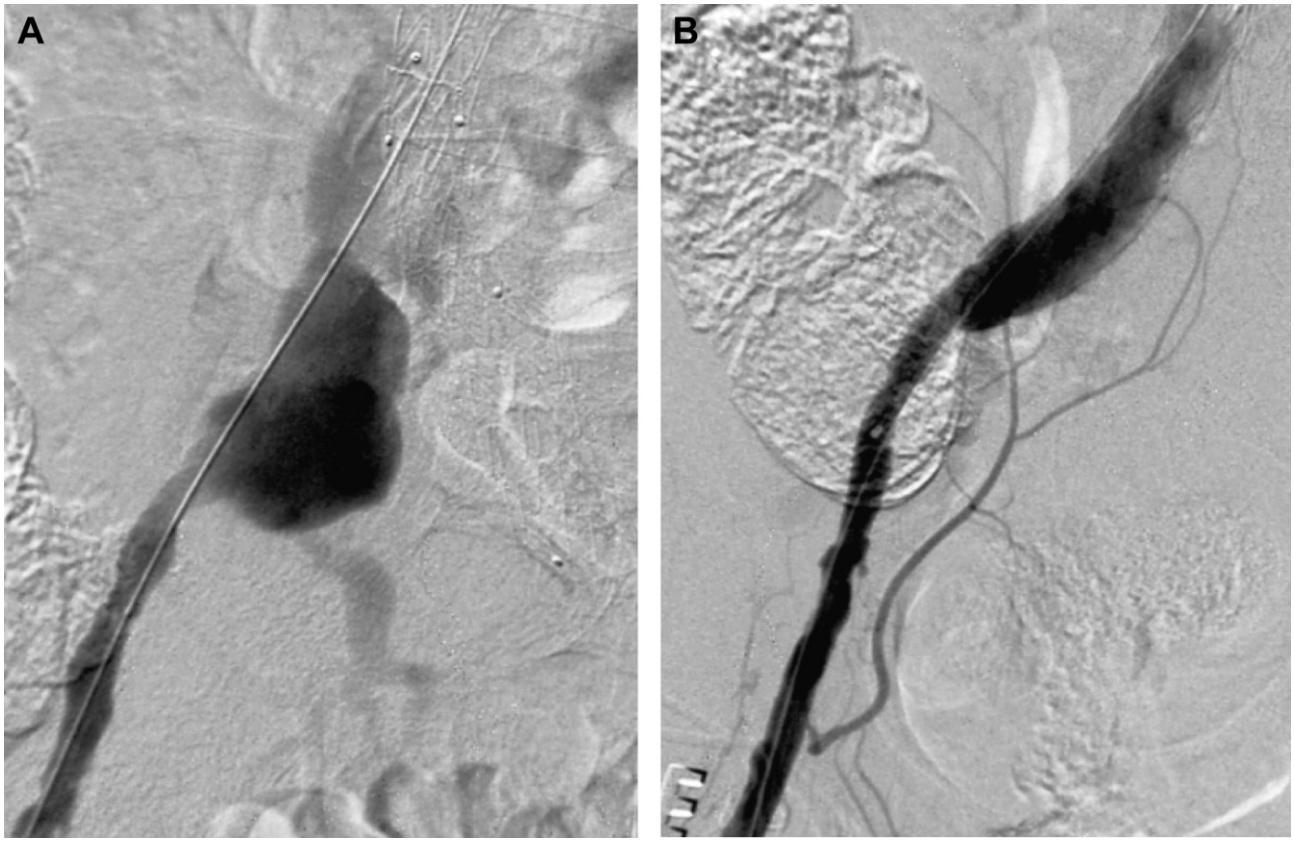

Figure 1. Intra-operative angiograms of a 73-year-old, male patient with a ruptured 59 mm aneurysm of the right CIA demonstrating; (A) CIAA with patent IIA before stent graft implantation, (B) stent graft implanted with extension into EIA, exclusion of CIAA with no signs of Type-II endoleaks, and filling of circumflex artery branches.

Table 3. Literature review of the incidence of buttock claudication and IIA-associated endoleaks following IIA stent coverage without prior coil embolisation.

Author/year (ref. no.)	No. of patients	Planned	Coil failure[a] or inadvertent	Mean follow-up (months)	Buttock claudication (%)	IIA-associated endoleaks (%)
Lee C 2000[18]	18	9	9	7.3	nr[b]	0 (0)
Karch 2000[19]	9	0	9	13.4	nr[b]	0 (0)
Rhee 2002[15]	6	0	6	4.7	nr[b]	0 (0)
Weyers 2002[25]	22	19	3	18.5	6 (27.3)	0 (0)
Mell 2006[27]	21	21	0	16.0	2 (9.5)	0 (0)
Bharwani 2008[24]	11	0	11	19.7	nr[b]	0 (0)
Farahmand 2008[23]	25	0	25	36.3	7 (28.0)	1 (4.0)[c]
Papazoglou 2012[28]	112	107	5	33.0	15 (13.4)	7 (6.3)[c]
Current study	31	27	4	14.3	7 (22.6)	0 (0)
Total	255				37 (17.5)	8 (3.1)[c]

[a] Attempted coil embolisation technically failed due to stenotic IIA or iliac tortuosity.
[b] Buttock claudication not reported or not specified for sole stent coverage.
[c] None of the endoleaks required secondary intervention.

unlike lumbar or inferior mesenteric artery coiling, be beneficial to aneurysm behaviour. For the worse, coil embolisation has several disadvantages. First and foremost, it may increase the risk of pelvic ischaemia.[11,18] It has been demonstrated that with more distal IIA occlusion, more complications occur.[18] In this respect, one could argue that simple stent-graft coverage of the IIA is to be preferred as this policy produces the most proximal occlusion as possible. Second, coil embolisation is accompanied by increased contrast load and radiation exposure and prolongs operating time. Moreover, it is a costly procedure, as often multiple coils are required to occlude a single IIA.[4,11,29] Considering the devices alone, the average costs to coil a single IIA are estimated to be 3500 USD.[11]

To our knowledge, the present series is the first to report the results of a policy of routinely abandoning embolisation of the IIA. Previous studies on EVAR with IIA coverage for aortoiliac aneurysms applied a selective approach in deciding whether or not to embolise the IIA; Bharwani et al.[22] and Farahmand et al.[21] only included cases without coil embolisation in which attempted embolisation had technically failed or in which the IIA had been covered inadvertently. The group from the University of Wisconsin presented two reports on patients with and without coil embolisation,[24,25] but no reasons were provided for their decision whether or not to perform concomitant IIA embolisation. Wyers et al.[23] decided not to embolise the IIA if a sealing zone of at least 5 mm was present in the most distal part of the CIA. A recent study by Papazoglou et al.[26] applied more liberal criteria: if no sufficient distal landing zone was present, IIAs with a diameter <5 mm were not coiled, which applied to 112 out of 137 cases (81.7%) that required limb-graft extension into the EIA.

Two factors may account for the fact that we did not observe IIA-related Type-II endoleaks. One is that in our series, the CIA just above the level of the iliac bifurcation was never aneurysmatic, even in cases of larger CIA aneurysms. Apparently, a short narrow-calibre segment at the iliac bifurcation is sufficient to provide adequate seal and to allow thrombosis of the main trunk of the IIA. Alternatively, one could hypothesise that a comparable situation exists in the abdominal aorta itself; literature data[27,28,30] have shown that only a minority of patients with patent lumbar arteries on preoperative imaging studies will eventually develop a Type-II endoleak following EVAR.

Overall, reports of IIA-associated endoleaks are rare, and so far, no study has been able to demonstrate an association between the occurrence of IIA-related endoleaks and omission of adjuvant occlusion measures. Similar to our study, most studies on sole IIA coverage did not observe Type-II endoleaks originating from the IIA at all.[13,16,17,22–25] In studies which report IIA-associated endoleaks incidences range between 4.0% and 6.2% (Table 3).[21,26] None of these cases, however, resulted in aneurysm expansion, nor did they require secondary interventions to resolve the endoleaks. Some of the Type-II endoleaks resolved spontaneously during follow-up.

In our series, no severe symptoms of pelvic ischaemia occurred, nor were any secondary interventions required to solve problems related to IIA coverage. The incidence of buttock claudication (22.6%) was within the range reported in previous studies on sole IIA coverage and compares favourably to the incidence reported in the majority of studies on coil embolisation. These findings support the suggestion that coil embolisation increases the risk for pelvic ischaemia. In patients with concomitant coil embolisation, the incidence of buttock claudication ranged from 16% to 53%,[6,24] whereas in patients undergoing stent coverage without coil embolisation it merely ranged from 0% to 28% (Table 3).[21,23–26] Although these symptoms may disappear within 6 months, a study by Mehta et al.[15] reported persistent buttock claudication in 12% of patients after 1 year.

Higher incidence and more severe presentation of symptoms are commonly associated with bilateral IIA occlusion.[14,15] This is in line with the findings in our study, in which symptoms of buttock claudication only persisted in the two (6.5%) patients with bilateral IIA coverage.

Our study has several limitations. One of these is that sexual dysfunction was not routinely queried. Therefore, limited value can be attributed to the reported absence of this complication in our population. Another limitation is

the retrospective design of our study, which might have caused relative underreporting in general. However, we consider specific questions with focus on pelvic ischaemia part of follow-up routine. With regard to the observed absence of IIA-related Type-II endoleaks, although one would not expect new Type-II endoleaks, a longer follow-up is required to assess the durability of this finding.

CONCLUSION

Endovascular treatment of aortoiliac and iliac aneurysms without pre-emptive coil embolisation of the IIA appears safe and effective, as no IIA-related endoleaks or re-interventions occurred in our series. This approach could save operating and radiation time, contrast load and expensive coils and may reduce complications. However, further research on a larger population and with longer follow-up is required to confirm our findings.

CONTRIBUTIONS

Study design: RS, EW, JT, MvS and PhC.
Data collection: RS, EW, JT, JtB and PhC.
Data analysis: RS, EW, JtB, MvS and PhC.
Writing: RS, EW, JT, JtB, MvS and PhC.

CONFLICT OF INTEREST/FUNDING

None.

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