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Original Article

Risk Factor Analysis for Buttock Claudication after Internal Iliac Artery Embolization with Endovascular Aortic Aneurysm Repair

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Purpose: Endovascular aneurysm repair (EVAR) of abdominal aortic aneurysms (AAAs) involving the common iliac artery requires extension of the stent-graft limb into the external iliac artery. For this procedure, internal iliac artery (IIA) embolization is performed to prevent type II endoleak. In this study, we investigated the frequency and risk factor of buttock claudication (BC) in patients having interventional embolization of the IIA.

Materials and Methods: From January 2010 to December 2013, a total of 110 patients with AAA were treated with EVAR in our institution. This study included 27 patients (24.5%) who had undergone unilateral IIA coil embolization with EVAR. We examined hospital charts retrospectively and interviewed by telephone for the occurrence of BC.

Results: Mean age of total patients was 71.9±7.0 years and 88.9% were males. During a mean follow-up of 8.65±9.04 months, the incidence of BC was 40.7% (11 of 27 patients). In 8 patients with claudication, the symptoms had resolved within 1 month of IIA embolization, but the symptoms persisted for more than 6 months in the remaining 3 patients. In univariate and multivariate analysis, risk factors such as age, sex, comorbidity, patency of collateral arteries, and anatomical characteristics of AAA were not significantly related with BC.

Conclusion: In this study, BC was a frequent complication of IIA embolization during EVAR and there was no associated risk factor. Certain principles such as checking preoperative angiogram, proximal and unilateral IIA embolization may have contributed to reducing the incidence of BC.

Key Words: Abdominal aortic aneurysm, Therapeutic embolization, Intermittent claudication, Risk factors

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INTRODUCTION

Abdominal aortic aneurysm (AAA) is a localized dilatation of the abdominal aorta. There are two surgical options for prevention of AAA rupture: open repair, and endovascular aneurysm repair (EVAR) [1,2]. EVAR was first presented by Parodi et al. [3] in 1991, and since then EVAR has been recognized as an accepted alternative to open surgical repair [4]. Improved endograft design and increasing experience with endovascular repair techniques have expanded the proportion of aneurysms that are suitable for EVAR [5].

Approximately 20% to 30% of patients with AAA have simultaneous common iliac artery aneurysm (CIAA) [6,7]. CIAA requires extension of the stent graft limb into the external iliac artery (EIA) and standard bifurcated stent grafts are used for this condition. The extension of stent graft into the EIA without obstruction of the internal iliac artery (IIA) can lead to type 2 endoleak. Embolization of the IIA is usually performed to prevent type 2 endoleak. Ischemic complications such as spinal cord ischemia, bowel ischemia, bladder ischemia, erectile dysfunction and buttock claudication (BC) are a major concern associated with sacrifice of the IIA [8,9].

BC is the most frequent ischemic complication and it can be disabling [10]. Finding out BC and its related condition after IIA embolization are very important to improve quality of life for patients. In this study, we investigated the frequency and natural course of BC in patients having embolization of the IIA during EVAR. Also we analyzed risk factors associated BC such as age, sex, comorbidity, smoking, anatomic characteristics and patency of collateral arteries. We additionally conducted a systematic review of the literature.

MATERIALS AND METHODS

1) Study population

From January 2010 to December 2013, 110 patients with AAA underwent EVAR in our institution. Among them, there were 27 patients (24.5%) with CIAA requiring extension of the stent graft into the EIA and IIA embolization.

2) Surgical procedure

When the aneurysm was close or involved the iliac bifurcation or when the common iliac artery (CIA) was too large to fit the available stent-grafts, we decided to cover the IIA. All embolization procedures were taken via contralateral femoral artery approach or left brachial approach. Anatomy and operator preference made the decision of approach. A long sheath was progressed over the wire beyond the desired level of the IIA. The adequate coils (Nestor Coils; Cook Medical Inc., Bloomington, IN, USA) were pushed out of the sheath into the target level of the IIA. We put a coil into the main trunk or first branch of the IIA. The purpose of putting the embolic material in the proximal portion of the IIA was to allow future peripheral collateralization from the IIA branches to decrease the risk of pelvic ischemia. Embolization was finished with angiographic documentation of minimal or absent antegrade flow into the IIA. Stent grafts were then deployed for aneurysm exclusion.

For patients with bilateral CIAAs, all patients underwent unilateral IIA embolization to avoid the risk of critical colon ischemia. Specifically, the contralateral IIA was preserved either by using a bell bottom technique (BBT) which stands for a large diameter limb stent-graft placed in the dilated CIA or by performing a bypass operation from the EIA to the IIA. CIAA is often treated with BBT, but this technique is limited to patients with larger aneurysms. When BBT was not able to be performed, bypass operation was performed as another option. Simultaneous repairs of CIAA and bypass operation from distal EIA to IIA were planned. An oblique skin incision was made on the lower abdomen to approach the iliac arteries. Following the division of the IIA, the proximal end was sealed using 4-0 polypropylene suture. The distal portion of the IIA was anastomosed with a 7-mm expanded polytetrafluoroethylene (ePTFE) graft. The other end of the ePTFE was end-to-side anastomosed with the distal EIA not covered with the stent graft.

3) Patient assessment

Three-dimensional computed tomographic angiography (3D CTA) was examined to plan for EVAR and to check the necessity for iliac limb extension and coverage of the IIA. 3D CTA was performed to review the aortoiliac anatomy, tortuosity of vessels, and IIA diameter. This data was used to determine the optimal approach for successful catheterization, the size of stent grafts and the ideal embolic material. Follow-up 3D CTA was performed within the postoperative 1 week and then at 6 months and every following year to determine the patency of the stent graft and occurrence of endoleak. Physical examination with pulse status and ankle-brachial index were taken with vascular Doppler. BC was defined as the new onset of buttock and upper thigh claudication that appeared in the same side of embolization immediately following EVAR. It was also referred to the side of IIA occlusion. Claudication of the lower limb as a symptom of further distal peripheral vascular disease was excluded. Patients were specifically asked for symptoms of new onset BC postoperatively and at every follow-up meeting (3, 6, and 12 months postoperative and then every 12 months). In telephone interviews, the patients were questioned specifically about symptoms of BC that had presented since they underwent EVAR. The onset, degree and progression of symptoms were recorded. Persistent BC was defined when it lasted more than six months.

4) Statistical analysis

We performed statistical analyses to assess differences

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Table 1. Patients' clinical characteristics

Characteristic	Non-buttock claudication (n=16)	Buttock claudication (n=11)	P-value
Age (y)	72.05±6.14	71.37±8.15	0.808
Male	15 (93.8)	9 (81.8)	0.549
Hypertension	7 (43.8)	5 (45.5)	0.930
Ischemic heart disease	2 (12.5)	3 (27.3)	0.370
Cerebrovascular accident	2 (12.5)	1 (9.1)	0.407
Diabetes mellitus	3 (18.8)	1 (9.1)	0.624
Chronic obstructive pulmonary disease	2 (12.5)	1 (9.1)	1.000
Hyperlipidemia	1 (6.3)	2 (18.2)	0.549
Chronic renal failure	0	1 (9.1)	0.407
Smoking	5 (31.3)	5 (45.5)	0.267

Values are presented as mean±standard or number (%).

Table 2. Anatomical characteristics of AAA or isolated iliac aneurysms

Anatomic characteristics	Non-buttock claudication (n=16)	Buttock claudication (n=11)
AAA with unilateral CIAA	9 (56.3)	4 (36.4)
AAA with bilateral CIAA	6 (37.5)	6 (54.5)
Isolated unilateral CIAA	1 (6.3)	1 (9.1)

Values are presented as number (%).
AAA, abdominal aortic aneurysm; CIAA, common iliac artery aneurysm.
Fisher's exact test, P=0.609.

Table 3. IIA and DFA patency

Patency	Non-buttock claudication (n=16)	Buttock claudication (n=11)
Both IIA and DFA patent	15 (93.8)	10 (90.9)
More than 1 artery occlusion	1 (6.3)	1 (9.1)

Values are presented as number (%).
IIA, internal iliac artery; DFA, deep femoral artery.
Fisher's exact test, P=1.000.

between the group with BC and the group with no claudication after coil embolization. Statistical analysis was performed using PASW Statistics ver. 18.0 (IBM Co., Armonk, NY, USA). Statistical comparisons between groups were made using the chi-square test or Fisher's exact test for qualitative variables, and by a t-test for continuous variables. All variables associated with BC were analyzed by univariate and logistic regression analysis. The hazard ratios with 95% confidence intervals were estimated from the model. P-values <0.05 were considered to be significant.

RESULTS

Twenty seven patients (24.5%) who underwent coil embolization of the IIA with extension of the stent graft to the EIA were included in this study. Demographic and clinical data of the patients are presented in Table 1. Mean age of the patients was 71.9±7.0 years and 88.9% were males. Ten patients (37.0%) were smokers. Hypertension (44.4%) was the most common comorbidity present in these patients followed by ischemic heart disease (18.5%) and diabetes (14.9%).

Anatomic characteristics of these patients are shown in Table 2. All patients had CIAA. Thirteen patients (48.1%) were identified as having AAA with unilateral CIAA. There were 12 patients (44.4%) having AAA with bilateral CIAA and 2 patients (7.4%) with isolated unilateral CIAA. Both IIA and deep femoral artery (DFA) patency was investigated (Table 3). Twenty five patients (92.6%) had good patency of these arteries. In all cases, we performed unilateral IIA embolization. Among the 12 patients with bilateral CIAA, contralateral CIA was managed with BBT in 7 patients and bypass surgery to the EIA in 5 patients. Primary technical success rate of IIA embolization was 100%. However one patient died from hypovolemic shock after EVAR with IIA embolization in whom a diagnosis of ruptured AAA had been made at the time of the hospital visit. One patient complained of progressive abdominal pain. After 4 days, we performed a sigmoidoscopy and the endoscopic finding showed subacute ischemic colitis. This patient underwent colon resection and colostomy. There was no vascular complication like dissection, hematoma and pseudoaneurysm.

The incidence of BC was 40.7% (11 of 27 patients). In 8 patients with BC, the symptoms had resolved within 1 month of IIA embolization, but the symptoms persisted for more than 6 months in the remaining 3 patients. To

Table 4. Results of risk factors for buttock claudication after internal iliac artery embolization for endovascular abdominal aneurysm repair

Variable	Univariate P-value	Multivariate	
		Hazard ratio (95% confidence intervals)	P-value
Age	0.885	0.933 (0.760-1.146)	0.508
Sex, male	0.549	0.455 (0.010-21.659)	0.690
Comorbidity			
Hypertension	0.930	0.625 (0.048-8.102)	0.719
Diabetes mellitus	1.000	1.187 (0.043-32.842)	0.919
Ischemic heart disease	1.000	2.186 (0.199-24.017)	0.522
Chronic obstructive pulmonary disease	1.000	0.368 (0.013—10.319)	0.557
Chronic renal failure	0.407	2.071 (0)	1.000
Cerebrovascular accident	1.000	1.713 (0.054-53.860)	0.760
Hyperlipidemia	0.549	1.854 (0.037-92.797)	0.757
Smoking	0.453	2.554 (0.364-17.919)	0.346
Both internal iliac artery and deep femoral artery patency	1.000	7.797 (0.108-564.599)	0.347
Anatomical characteristics of abdominal aortic aneurysm	0.688	0.261 (0.005-14.176)	0.778

Table 5. Review of the literature

First author, year	Patients no.	Claudication (n, %)	Risk factor for buttock claudication
Criado et al., 2000 [14]	39	5 (12.8)	Bilateral IIA embolization
Cynamon et al., 2000 [17]	34	13 (38.2)	Distal embolization
Karch et al., 2000 [20]	22	7 (31.8)	Bilateral IIA embolization
Yano et al., 2001 [8]	103	21 (20.3)	Vascular anatomy
Schoder et al., 2001 [11]	46	21 (45.7)	Bilateral IIA embolization
Mehta et al., 2001 [12]	107	17 (15.9)	Distal embolization, shock, failure to preserve collateral branches from the external iliac and femoral arteries
Lin et al., 2002 [15]	12	6 (50.0)	Diseased DFA
Kritpracha et al., 2003 [16]	20	9 (45.0)	Distal embolization
Mehta et al., 2004 [18]	32	5 (15.6)	Distal embolization
Bratby et al., 2008 [19]	39	12 (30.8)	Distal embolization
Farahmand et al., 2008 [22]	101	51 (50.5)	Left ventricular dysfunction
Park et al., 2014 [21]	42	10 (23.8)	Age
First author, year	Patients no.	Claudication (n, %)	Suggestion to reduce buttock claudication
Arko et al., 2004 [25]	12	6 (50.0)	Use of IIA bypass
Mehta et al., 2004 [18]	32	5 (15.6)	Adequate heparinization Staging bilateral IIA embolization
Verzini et al., 2009 [24]	37	8 (21.6)	Use of side branch endograft
Wu et al., 2011 [23]	106	17 (16.0)	Use of Amplatzer vascular plug Adequate heparinization

IIA, internal iliac artery; DFA, deep femoral artery.
Amplatzer vascular plug (AGA Medical Corp., Golden Valley, MN, USA).

identify the risk factors for BC after IIA embolization, we performed univariate and multivariate analysis (Table 4). In univatiate analysis, age and sex were not associated with the development of BC (P=0.885 and P=0.549, respectively). BC occurred in 10 patients (37.0%) who had patent both IIA and DFA. There was no association with vessel patency and BC (P=1.000). No comorbidity was related with BC. In multivariate analysis by logistic regression analysis, age, sex and comorbidities were not associated with BC. The patency of collateral arteries and the anatomical characteristics of

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AAA were not significant related factors for BC (P=0.347 and P=0.778, respectively)

DISCUSSION

It has been reported that the frequency of BC varies from 13% to 50% after IIA embolization. The incidence of BC was more common after bilateral IIA embolization compared with unilateral IIA embolization [10]. In our study, BC occurred in 40.1% of patients following unilateral IIA embolization with EVAR. This is comparable with previous results. IIA embolization is a good treatment option to prevent type 2 endoleak from the IIA when the stent graft limbs need to be extended into the EIA [11]. Because the IIA is the major artery of the pelvis and supplies the blood to the pelvic organs and buttock muscles, the sacrifice of the IIA by embolization may cause pelvic ischemic complications such as colonic ischemia, buttock and pelvic organ necrosis, lower limb neurological deficits, and paraplegia [8,12-14].

In our study, we did not find any associated factors with incidence of BC. There are a few studies concerning the influencing factors on the ischemic complications, especially BC, after IIA embolization (Table 5). Some studies suggested that perioperative angiogram can help to identify the patients with high risk for BC. Yano et al. [8] investigated radiographic findings to identify vascular structures associated with pelvic ischemia after IIA occlusion. They suggested that two vascular anatomies may help to predict ischemic complications: more than 70% stenosis of the remaining IIA origin and small caliber, diseased or absent ascending deep femoral branches ipsilateral to the side of the IIA occlusion. Lin et al. [15] reported that patients with diseased DFA have a risk for development of pelvic ischemia after IIA. In our data, the patency of collateral arteries was not associated with BC. The reasons for the difference of incidence may have originated from regional differences, study method, patient characteristics, surgical technique and so on. The location of IIA embolization could also affect BC. The occurrence of BC is more common in patients with coils placed distal to the first branch of the IIA, compared with patients with proximal placement of coils for IIA embolization [16,17]. Mehta et al. [12,18] also suggested that proximal IIA embolization may have contributed to the low incidence of pelvic complications. Bratby et al. [19] assessed the outcomes of bilateral IIA embolization prior to EVAR. In their study, proximal embolization limited to the main trunk of the IIA was significantly associated with a reduced ischemic complication rate compared with a more distal embolization of the IIA (16% vs. 55%, P=0.019). When coils are placed in the IIA, the vascular branches from the orifice of the IIA to coil do not provide blood flow to the pelvic area. So there is a high chance that proximal IIA embolization can preserve pelvic collateral circulation. Because we had always put coils into the main trunk or first branch of the IIA, we could not compare the differences according to the location of embolization. In order to reduce BC, unilateral IIA embolization is preferred over bilateral IIA embolization [20]. In the study by Schoder et al. [11], the incidence of mild to severe new onset BC was 13 out of 36 patients (36.1%) with unilateral and 8 out of 10 patients (80%) with bilateral IIA embolization (P=0.03). In a systematic review study, the incidence of BC was 29% in unilateral IIA embolization and 32% in bilateral IIA embolization [10]. However, some studies suggested that BC occurs regardless of unilateral or bilateral IIA embolization [12,15]. We performed unilateral IIA embolization to all patients. Contralateral IIA was preserved with BBT or bypass operation from EIA to IIA. Some authors presented age [21], shock [12] and left ventricular dysfunction [22] as risk factors for BC.

Regarding IIA coil embolization, some methods such as Amplatzer vascular plug (AGA Medical Corp., Golden Valley, MN, USA) [23], side branch endograft [24], IIA bypass [25] and adequate heparinization [18] have been proposed as ways to reduce ischemic complications.

CONCLUSION

IIA embolization with EVAR has expanded the indications for EVAR. However, operators should keep in mind that IIA embolization can induce ischemic complications and should try to reduce it. There was no associated risk factor in our study. Certain principles such as checking preoperative angiogram, proximal and unilateral IIA embolization may have contributed to reducing the incidence of BC.

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