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# In Treatment of Popliteal Artery Cystic Adventitial Disease, Primary Bypass Graft not Always First Choice: Two Case Reports and a Review of the Literature **CME**

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## KEYWORDS

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**Abstract** Cystic adventitial disease (CAD) is a rare cause of unilateral intermittent claudication of unknown aetiology, which is characterized by the formation of multiple mucin-filled cysts in the adventitial layer of the arterial wall resulting in obstruction to blood flow. The disease predominantly presents in young otherwise healthy males and most commonly affects the popliteal artery. CAD can be diagnosed by magnetic resonance imaging, computed tomographic angiography, or duplex ultrasound. Surgery is the primary mode of treatment, including exarterectomy, or replacement of the affected vascular segment by venous or synthetic interposition graft. Alternatively, the cysts can be drained by percutaneous ultrasound-guided needle aspiration. We provide a literature update on the aetiology and treatment of this uncommon condition and present two cases supporting patient tailored treatment without primary bypass grafting.

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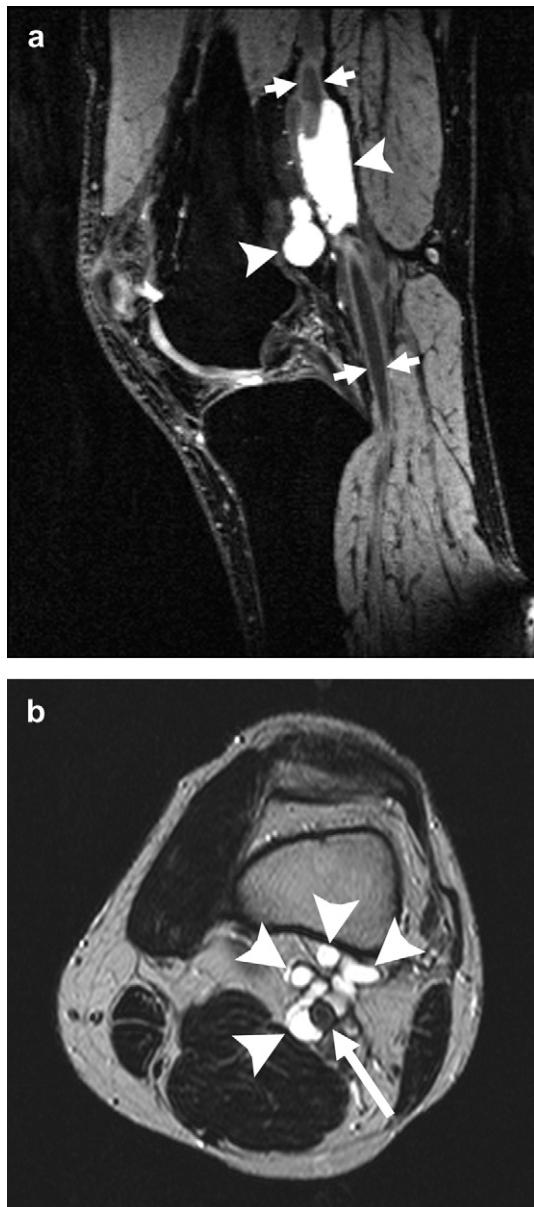
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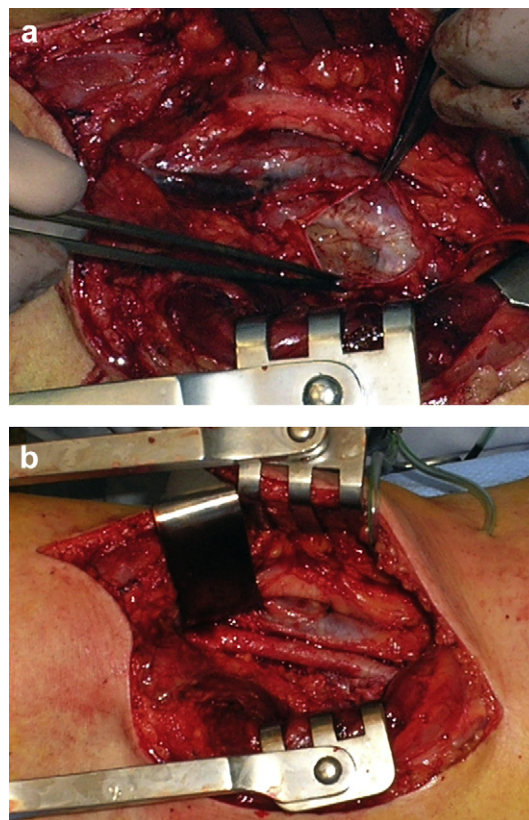
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## Case 1

A 40-year-old male patient presented at the outpatient clinic with intermittent claudication of the left calf during running. Magnetic resonance imaging (MRI) showed cystic deformities in close proximity to the popliteal artery (Figs. 1a and 1b). The diagnosis of cystic adventitial disease (CAD) was confirmed during surgical exploration. A successful exarterectomy of the popliteal artery was performed through a dorsal approach (Figs. 2a and 2b). Postoperative recovery was uneventful and the patient resumed full exercise after 3 months. During 3 years of follow-up, the patient did not demonstrate any symptoms of relapse.



**Figure 1** (a) Sagittal T2 weighted 3D gradient image using a dual echo steady state technique with water excitation. Cystic structures (arrowheads) are in close contact with the popliteal artery (arrows). (b) Axial T2 weighted turbo spin echo image showing multiple cystic structures (arrowheads) in relation to the popliteal artery (arrow).



**Figure 2** (a) Cyst opened between two forceps. (b) After exarterectomy.

## Case 2

A 41-year-old male patient was admitted to the hospital with acute ischaemia of the right lower leg due to occlusion of the popliteal artery. The patient was successfully treated with catheter-directed thrombolysis. Magnetic resonance angiography (MRA) demonstrated cystic changes of the right popliteal artery supporting the diagnosis of CAD. The largest cysts were successfully drained by ultrasound-guided percutaneous needle aspiration. Recovery was uneventful. At 26 months of follow-up, the patient was still free of symptoms and no signs of recurrence were revealed by MRA.

## Discussion

The condition of CAD, also known as cystic adventitial degeneration, was first reported in 1947 by Atkins and Key, describing a case of intermittent claudication in a young male patient caused by cystic deformation of the external iliac artery.<sup>1</sup> Since the original report, more than 350 cases of CAD have been published. CAD is located in the popliteal artery in 85–90% of cases, and is usually unilateral. Cystic changes have also been identified in other lower- and upper-extremity arteries, including the external iliac, axillary, distal brachial, radial and ulnar arteries. The cysts in the adventitial layer of the blood vessel wall may narrow the arterial lumen and compromise blood flow. Given the

usual location of CAD in the popliteal artery, the disease commonly presents with unilateral intermittent claudication in the calf. Albeit extremely rare, cysts may also form in vein walls, leading to venous thrombosis.<sup>2</sup> The estimated incidence of CAD among patients with intermittent claudication is 1:1200. The disease predominantly affects men, with a male to female ratio of 15:1. Age at presentation ranges between 10 and 70 years, with a peak incidence at 40–50 years. CAD is not related to atherosclerosis or its risk factors. In addition to CAD, the differential diagnosis of intermittent claudication in young patients with no risk factors for atherosclerosis includes popliteal artery entrapment syndrome, fibromuscular dysplasia, endofibrosis, Bakers' cyst and popliteal artery aneurysm.<sup>3</sup>

## Aetiology

The cysts in CAD are composed of fibrous connective tissue and contain mucinous gel with mucoproteins and mucopolysaccharides, resembling the contents of a ganglion. It is not known how and why these cysts are formed. The various theories on the origin of adventitial cyst formation can be categorised into five groups<sup>4</sup>:

- (1) destruction and cystic degeneration of the arterial adventitia due to repetitive (micro)trauma by stretching and distortion of an arterial segment adjacent to a joint;
- (2) implantation of adjacent synovial cells into the adventitia (ectopic aganglionosis);
- (3) degeneration of adventitia associated with systemic connective tissue diseases<sup>5</sup>;
- (4) implantation of mesenchymal cells from nearby joints into the adventitia of blood vessels during embryonic development (developmental theory); and
- (5) herniation of synovium from the adjacent joint into the arterial wall.<sup>6</sup>

In 30% of cases, the adventitial cysts completely compress the arterial lumen, resembling an endoluminal lesion, while in other cases imaging shows a normal vascular lumen.<sup>7,8</sup>

## Clinical presentation

Typically, CAD presents as rapidly progressive unilateral, intermittent, calf claudication in a healthy middle-aged non-smoking man with no risk factors for atherosclerotic cardiovascular disease. The intermittent nature of symptoms in CAD is not completely understood. It is hypothesised that a connection between the knee joint with filling of the adventitial cysts upon excessive knee joint movement induces intermittent compression of the artery, resulting in claudication.<sup>9</sup> The long recovery period of 20 min after the onset of exercise-induced claudication might be due to the elevation of the pressure in the cyst and the slow reabsorption of the mucous fluid by the cyst wall, while the valve mechanism prevents return of mucus into the knee joint.<sup>10</sup> Rarely, CAD presents as acute-onset limb pain due to bleeding in the cyst or rupture of the

cyst,<sup>11</sup> or, alternatively, as acute limb ischaemia due to thrombosis of the affected arterial segment.<sup>4,7</sup>

## Diagnosis

Physical examination usually reveals no apparent circulatory abnormalities in the lower extremities with palpable peripheral arterial pulsations. In some patients, passive flexion of the knee may induce disappearance of foot pulsations consequent to compression of the popliteal artery by large adventitial cysts, which is known as the Ishikawa sign.<sup>12</sup> The ankle–brachial index is usually normal in rest, and may decrease after exercise when the pressure in the cyst increases sufficiently to provoke haemodynamic changes due to endoluminal stenosis.<sup>13</sup> The presence, location and dimensions of adventitial cysts as well as their potential communication with the adjacent joint can be identified by duplex ultrasound,<sup>14</sup> computer tomography, CT angiography (CTA) or MRA. These non-invasive imaging modalities have largely replaced conventional diagnostic angiography.<sup>15,16</sup> MRI and MRA are the preferred imaging modalities as they can precisely evaluate the condition of the affected artery. MRI can demonstrate the cyst originating from the vessel wall and its connection to the adjacent joint. MRA shows the stenosis or occlusion of the affected vessel.<sup>17,18</sup>

## Treatment

Over the past decade, various treatments have been attempted for CAD. The first cases of CAD were treated by resection of the affected arterial segment and replacement by an interposition graft, either venous,<sup>19</sup> arterial homograft<sup>20</sup> or synthetic graft.<sup>21,22</sup> In the 1960s, alternative treatments were reported, including excision of a cyst with the outer layer of the arterial wall<sup>12,23</sup> and percutaneous needle aspiration of cysts in the wall of the popliteal artery.<sup>24,25</sup>

In 1979, Flanigan summarised 115 known cases of CAD.<sup>26</sup> Since then, several case reports have been published. Using PUBMED, we did a literature search for articles that have been published since Flanigan's publication, using the keywords popliteal artery, cystic adventitial disease, cystic arterial disease and intermittent claudication. Publications accessible in the extensive university medical centre's electronic library were reviewed. Languages were restricted to English, German and Dutch. Only the case reports that describe CAD of the popliteal artery and not the even less common cases concerning the disorder located in other arteries (e.g., the external iliac, axillary, distal brachial, radial and ulnar arteries) were included in this review. Following this strategy, we included 61 cases in our literature update. Table 1 provides an overview of all studies of CAD of the popliteal artery reporting patient sex and age, site of lesion, surgical technique and its outcome. A total of 68 procedures have been described in 61 patients (53 male, 9 female). Mean age at diagnosis was 43 years (10–75). In one patient both legs were affected,<sup>32</sup> in 32 only the left leg and in 28 cases the right leg. The surgical techniques that were most frequently used included resection of the affected arterial segment with an autologous venous interposition

**Table 1** Summary of reported cases since 1979.

Year	Author	Sex	Age	Side	Treatment
2010	Maged et al. <sup>18</sup>	1: F	48	Left leg	Patient 1: Ven + Patient remains asymptomatic 3 years after surgery
		2: M	18	Left leg	Patient 2: Cyst excision Recurrent symptoms after 6 months → PTA Patient remains asymptomatic 2 years after surgery.
		3: M	43	Left leg	Patient 3: Bypass + Patient remains asymptomatic 2 years after surgery.
2009	Michaelides et al. <sup>15</sup>	M	53	Right leg	Cyst excision Patient remains asymptomatic 18 months after surgery.
2009	Taurino et al. <sup>13</sup>	M	34	Right leg	Ven + Patient remains asymptomatic 15 months after surgery.
2009	Maged et al. <sup>33</sup>	M	18	Left leg	PTA Patient remains asymptomatic 2 years after surgery.
2009	Motaganahalli et al. <sup>34</sup>	M	40	Left leg	Cyst excision Good recovery, no follow-up data.
2009	Mino et al. <sup>35</sup>	F	35	Right leg	Ven – Good recovery, no follow-up data.
2008	Sharma <sup>36</sup>	M	32	Left leg	Cyst excision Patient remained asymptomatic 3 months after surgery.
2008	Patel et al. <sup>37</sup>	M	41	Left leg	Prosth - Recurrence of the cysts after 1 year causing swelling of the foot → continuing of duplex ultrasound every 3 months. Patient remains asymptomatic 6 months after starting ultrasound follow-up
					Cyst excision Patient remains asymptomatic 20 months after surgery.
2008	Tomasian et al. <sup>38</sup>	M	26	Right leg	Ven – Patient remains asymptomatic 12 months after surgery.
2008	Pannone et al. <sup>39</sup>	M	51	Right leg	Ven + Patient remains asymptomatic 1 year after surgery.
2007	Tsilimparis et al. <sup>40</sup>	M	54	Right leg	Ven – Patient remains asymptomatic 1 year after surgery.
2007	Nano et al. <sup>41</sup>	F	43	Left leg	Prosth + Patient remained asymptomatic 1 year after surgery.
2007	Papas et al. <sup>42</sup>	F	54	Left leg	Ven + Patient remains asymptomatic 1 month after surgery.
2007	Ji-Sun Hong et al. <sup>43</sup>	M	58	Left leg	Ven – (both legs) Recurrent symptoms in right leg after 4 months, successfully treated with PTA. Patient is currently asymptomatic.
2006	Ortiz et al. <sup>32</sup>	M	58	Left & Right leg	Ven – (both legs) Patient remains asymptomatic 2 years after surgery.
2006	Buijsrogge et al. <sup>9</sup>	M	35	Left leg	Ven + Patient remains asymptomatic 5 months after surgery.
2006	Lee et al. <sup>44</sup>	M	30	Left leg	Exarterectomy All 6 patients remained asymptomatic 10–15 years after surgery. Two patients developed a new Baker's cyst, not involving the artery.
2005	Stierli et al. <sup>45</sup>	5 M 1 F	Mean age 49 (25–70)	2 Left leg 4 Right leg	Failed needle aspiration → cyst excision. Patient remains asymptomatic 14 years after surgery.
2005	Cassar <sup>7</sup>	M	36	Left leg	Bypass + Good recovery, no follow-up data
2005	Vasudevan et al. <sup>46</sup>	M	54	Right leg	



Table 1 (continued)

Year	Author	Sex	Age	Side	Treatment
2005	de Klerk et al. <sup>31</sup>	1: M	48	Right leg	Patient 1: Ven + Patient remains asymptomatic 12 months after surgery.
		2: M	44	Left leg	Patient 2: Exarterectomy Patient remains asymptomatic 12 months after surgery.
		3: M	51	Left leg	Patient 3: PTA → restenosis of 80% → Ven + Patient remains asymptomatic 19 months after surgery.
2004	Fox et al. <sup>47</sup>	M	40	Right leg	Ven + Patient remains asymptomatic 1 year after surgery.
2004	Khoury <sup>27</sup>	F	50	Left leg	Failed PTA → Bypass – Patient remains asymptomatic 1 year after surgery.
2001	Mellado and Salvadó <sup>48</sup>	M	56	Left leg	Cyst excision Good recovery, no follow-up data.
2001	Foster et al. <sup>49</sup>	M	44	Right leg	Ven + Patient remains asymptomatic 6 months after surgery.
2000	Rückert and Taupitz <sup>50</sup>	M	53	Right leg	Exarterectomy Patient remains asymptomatic 28 months after surgery.
2000	Unno et al. <sup>51</sup>	M	40	Left leg	Ven + Good recovery, no follow-up data.
1999	Ricci et al. <sup>11</sup>	M	47	Right leg	Ven + Good recovery, no follow-up data.
1998	Galle et al. <sup>52</sup>	M	25	Left leg	Ven + Patient remains asymptomatic 1 year after surgery.
1998	Tsolakis et al. <sup>53</sup>	F	49	Right leg	Prosth – Good recovery, no follow-up data.
1998	Levien and Benn <sup>4</sup>	1: M	58	Right leg	Patient 1: Ven + Patient remained asymptomatic 5 years after surgery.
		3: M	44	Right leg	Patient 3: failed cyst excision → Ven + Patient remained asymptomatic 3 years after surgery.
		4: M	42	Right leg	Patient 4: Prosth + Patient remained asymptomatic 2 years after surgery.
		5: M	48	Left leg	Patient 5: Cyst excision Patient remained asymptomatic 2 years after surgery.
		6: M	54	Left leg	Patient 6: failed endarterectomy → Ven + Patient remained asymptomatic 8 years after surgery.
1997	Miller et al. <sup>54</sup>	M	75	Right leg	Cyst excision Patient remains asymptomatic 1 year after surgery.
1997	Do et al. <sup>55</sup>	1: M	48	Right leg	7 Patients: needle aspiration Patients remained asymptomatic during follow-up (mean, 14.8 months after surgery).
		2: F	47	Right leg	
		3: M	42	Left leg	
		4: M	50	Left leg	
		5: M	45	Right leg	
		6: M	62	Left leg	
		7: M	44	Left leg	
1996	Koppensteiner et al. <sup>56</sup>	F	34	Left leg	Ven + Good recovery, no follow-up data.
1995	Ishibashi et al. <sup>57</sup>	M	14	Right leg	Ven + Restenosis after 50 months with no symptoms.
1987	Jasinski et al. <sup>58</sup>	M	27	Right Leg	Cyst excision Patient remains asymptomatic 5 months after surgery.
1984	Chapman and Pinkerton <sup>59</sup>	M	37	Right leg	Ven + Good recovery, no follow-up data.
1980	Bunker et al. <sup>60</sup>	1: M	38	Left leg	Patient 1: Ven + Good recovery, no follow-up data.
		2: M	59	Right leg	Patient 2: Ven + Good recovery, no follow-up data.
1980	Velasquez et al. <sup>61</sup>	1: M	43	Left leg	Patient 1: Cyst excision Good recovery, no follow-up data.

(continued on next page)

Table 1 (continued)

Year	Author	Sex	Age	Side	Treatment
		2:M	15	Left leg	Patient 2: Ven Good recovery, no follow-up data.
1979	England et al. <sup>62</sup>	M	10	Left leg	Cyst excision Patient remains asymptomatic 3 months after surgery.

1. Cyst excision, cyst excision with preservation or reconstruction of arterial wall.
2. Grafts and bypasses: prosth +, resection of affected arterial segment and interposition of prosthetic graft; prosth -, cyst excision and interposition of prosthetic graft; ven +, resection of affected arterial segment and interposition of venous graft; ven -, cyst excision and interposition of venous graft; bypass +, resection of affected arterial segment and venous bypassing; bypass -, venous bypassing of affected arterial segment.
3. Needle aspiration, open or ultrasound-guided percutaneous needle aspiration of cysts.
4. Exarterectomy, resection of adventitial layer of the arterial wall.
5. Endarterectomy, resection of intimamedial layer of the arterial wall.
6. PTA, percutaneous transluminal angioplasty.

graft in 20 case reports and adventitial cyst excision with preservation of the arterial wall in 13 cases. In seven cases treated by resection of the arterial segment and interpositioning of a venous graft, no follow-up data were reported. In one case, asymptomatic restenosis occurred after 50 months. In the remaining 12 cases, patients remained asymptomatic after a mean follow-up of 26.3 months (1–96). In three of the cases successfully treated with cyst excision, no follow-up data were reported. One case showed recurrent symptoms and in one case cyst excision failed, requiring resection of the affected arterial segment and interpositioning of a venous graft. In the remaining eight cases, patients remained asymptomatic with a mean follow-up of 31.6 months (3–168).

Of the reported cases, ultrasound-guided percutaneous needle aspiration of adventitial cysts failed in one case and was successful in seven patients with a mean asymptomatic follow-up period of 14.8 months. Operative or percutaneous drainage of the adventitial cysts by percutaneous needle aspiration of the cysts has an early recurrence rate of 10%.<sup>27</sup>

Exarterectomy is an alternative surgical technique in which the affected layers of the arterial wall are resected. This procedure was reported in eight cases, all with

a successful outcome. Surprisingly, endarterectomy was reported in one case, which failed.<sup>4</sup> Complete spontaneous recovery of symptoms has been described in occasional cases, for example when the cysts of the arterial wall communicate with the knee joint.<sup>28–30</sup> Percutaneous transluminal angioplasty (PTA) is a rarely used technique, with only four cases published since 1975.<sup>27,31–33</sup> In two of these cases, the intervention failed and required surgical intervention with interposition grafting or bypass surgery.<sup>27,31</sup> Maged et al. described a case in which PTA was successful, probably because the patient had previously been treated with surgical cyst enucleation, and scarring of the arterial wall had occurred.<sup>33</sup> Ortiz described a successfully performed PTA in a patient, who had recurrent symptoms after treatment with cyst excision and venous graft interposition.<sup>32</sup> Table 2 shows an overview of the techniques described.

## Conclusions

Based on this literature review of case reports, it is hard to determine the best surgical treatment option for CAD. Because of the rarity of this condition, no clinical trials have been performed. Unfortunately, in several reports, results are poorly described, including lack of follow-up data in 12 cases. Furthermore, there may be a significant publication bias due to reporting of successful cases only. Although a definite success rate of the various procedures cannot be given, the review of case reports shows that surgical exarterectomy and percutaneous needle aspiration of the cysts offer good and less invasive alternatives to conventional surgical treatment, including excision of the affected arterial segment followed by interposition grafting or bypass surgery. However, resection of the affected segment followed by interposition of an autologous venous graft should be the technique of choice when the artery is completely occluded or when there is degeneration of the medial layer of the arterial wall.

## Conflict of Interest/Funding

None.

Table 2 Techniques described.

Technique	Number of cases	Success	Failure
1. Cyst excision	13	11	2
2. Grafts and bypasses			
a) Prosth +	2	2	0
b) Prosth -	2	2	0
c) Ven +	20	19	1
d) Ven -	7	6	1
e) Bypass +	2	2	0
f) Bypass -	1	1	0
3. Needle aspiration	8	7	1
4. Exarterectomy	8	8	0
5. Endarterectomy	1	0	1
6. PTA	4	2	2
Total	68	60	8

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