

Optimal treatment of unligated side branch of internal mammary artery: Coil, amplatzer vascular plug or graft stent? A case report and literature review

**Bağlanmamış internal mamaryan arterinin optimal tedavisi nedir?
Coil, Amplatzer vascular plug, graft stent? Olgu sunumu ve literatür taraması**

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Summary- Coronary artery steal syndromes may occur following coronary artery bypass grafting as a result of the presence of large side-branches arising from the internal mammary artery (IMA). Coil embolization, Amplatzer Vascular Plug and graft stents are all used for the treatment of such syndromes. The literature contains limited data on the long-term success of these treatment methods. There is no large series regarding occluded IMA side branches causing coronary steal phenomena, and data on long-term follow-up of this treatment method is also very limited. This report presented two cases and their treatment, and reviewed the advantages and disadvantages of treatment methods and the factors that affect successful treatment.

Özet- Koroner arter çalma sendromu, koroner arter baypas ameliyatı yapılan ve internal mamaryan arterinin (IMA) büyük yan dallarının varlığının devamında görülebilir. Bu istenmeyen durumun tedavisinde coil embolizasyonu, Amplatzer vascular plug ve graft stent kullanılabilir. Literatürde bu tedavi metodlarının uzun dönem takibi ile ilgili sınırlı sayıda veri vardır. Literatürde koroner çalışma fenomenine neden olan IMA yan dalının tikanması ile ilgili büyük çalışma bulunmamaktadır. Bununla birlikte bildirilmiş olgu sunumlarının çoğu coil embolizasyonu tercih edilen yöntemdir. Bu yöntemin uzun dönem sonuçları ile ilgili çok sınırlı veri bulunmaktadır. Bu yazında iki olgu sunumu sunuldu, tedavi yöntemlerinin avantaj, dezavantaj ve başarısını etkileyen kritik noktalar tartışıldı.

In coronary artery bypass graft (CABG) surgery, use of the internal mammary artery (IMA) is preferred, as its long-term patency rate is better than that of the saphena graft.^[1] Post-operative angina is rarely seen due to diversion of blood from the myocardium into the large intercostal branches of the IMA. Transcatheter coil, gelatin sponge, graft stent and amplatzer vascular plug (AVP) occlusion of the IMA side branch are all performed to treat coronary steal syndrome.^[2]

Abbreviations:

AVP	Amplatzer vascular plug
CABG	Coronary artery bypass graft
CSG	Coronary graft stent
GDA	Gastro duodenal artery
IMA	Internal mammary artery
LAD	Left anterior descending
LCx	Left circumflex artery
RCA	Right coronary artery

Existing data in published case reports are limited. In the literature, coil occlusion is the most frequent treatment for coronary steal syndrome due to LIMA side branch.

CASE REPORT

Case 1- A 57-year-old woman was admitted to our hospital with typical angina. Risk factors present were hypertension and hyperlipidemia. Ten years previously, she had undergone a CABG operation with a sole LIMA-left anterior descending (LAD) artery anastomosis. Six years after this surgery, a coronary angiography was performed in another centre due to angina pain. At the present admission, there were no signifi-

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cant lesions in the left circumflex artery (LCx) or right coronary artery (RCA). However, LAD had an 80% stenotic segment. The LIMA-LAD graft was patent, with an existing side branch of the lateral thoracic artery. Myocardial perfusion scintigraphy showed anterior ischemia, so the lateral internal thoracic artery was embolized with two coils. The patient's angina disappeared and new electrocardiography showed 0.5 mm ST segment depression in precordial derivations. In echocardiography, left ventricular ejection fraction was 65% and there was no wall motion abnormality. In transfemoral coronary angiography, there were minor atherosclerotic plaques in the RCA and LCx arteries and an 80% stenotic segment in LAD. The LIMA-LAD graft was patent, providing a large branch of the lateral internal mammary artery with TIMI III flow. Inside this side branch, the two coils were visible (Fig. 1a).

Three weeks later, the LIMA was cannulated with a 6F IMA guiding catheter via the left brachial artery. A 0.014 wire (terumo guide wire gt with gold coil) was carried forward to the lateral internal mammary artery. A micro catheter system (terumo progreat micro catheter system) was advanced via the conveyor system wire. Four 2 mm/2 cm coils (microplex 10 coil system, helical soft) were released and 5 minutes later flow ceased (Fig. 1b). The procedure was finalized without complication and the patient was discharged

with a fixed treatment. She is presently being followed up in her seventh month and is without symptoms.

Case 2— A 65-year-old patient was admitted to our clinic with typical chest pain. He had undergone CABG 12 years previously. Two years after this, coronary angiography performed in another clinic revealed significant stenosis in the LIMA-LAD anastomosis area. There was also a LIMA side branch causing coronary steal syndrome. A bare metal stent was implanted to the LIMA-LAD anastomosis and the LIMA side branch was occluded with 2 coils (5 mm diameter, 20 mm long self expanding complex coils). Approximately 1 month later, another coronary angiography was performed due to recurrent angina, and showed TIMI 3 flow in the LIMA side branch. This side branch was occluded using a Jostent coronary graft stent (CSG) implanted to LIMA.

In 10th year of follow-up after this procedure, his anginal symptoms re-emerged and another coronary angiography was performed in our clinic. Native coronary arteries were all totally occluded proximally. The saphena-circumflex obtuse marginatus graft was patent. Other saphena grafts were occluded. In the LIMA-LAD anastomosis area, 90% in-stent stenosis was found (Fig. 2a). However, the graft stent in LIMA had no significant stenosis (Fig. 2b). Anginal complaints were related to in-stent restenosis in the anastomosis area, so percutaneous transluminal coronary

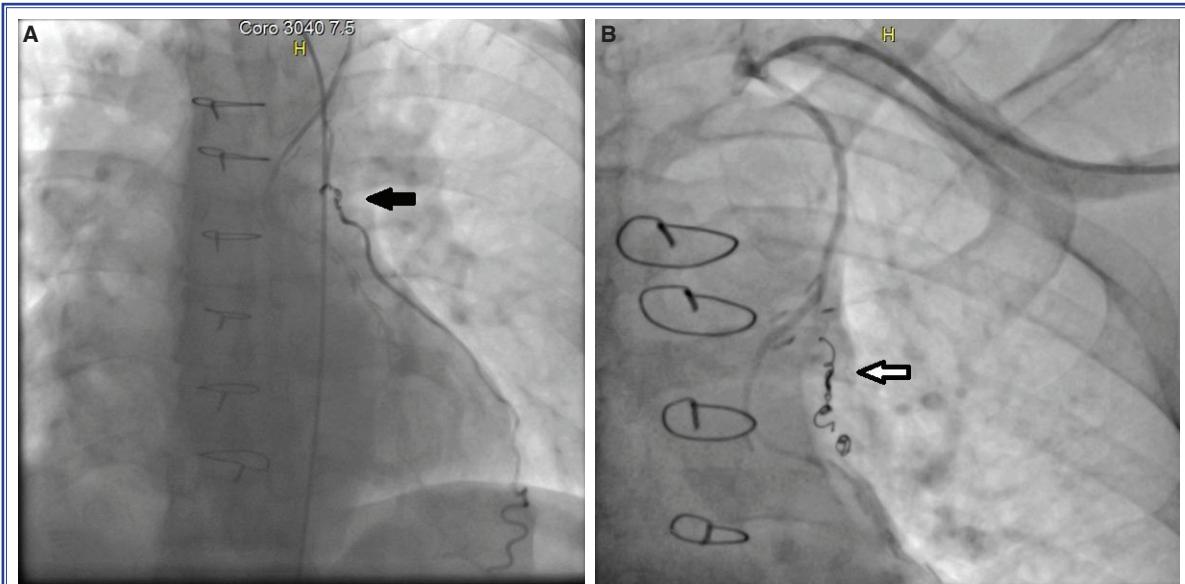


Figure 1. (A) Flow and two coils found in the large side of IMA. (B) IMA side branch occlusion was achieved with four-coil embolization.

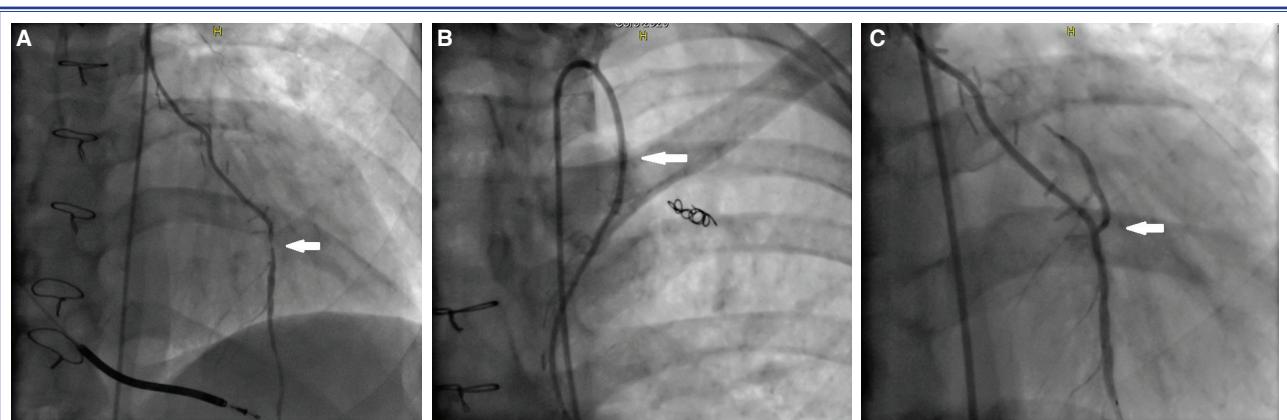


Figure 2. (A) 90% stenosis in LIMA-LAD anastomosis. (B) No significant restenosis was detected in the graft-stent in the LIMA. (C) After balloon angioplasty, full patency was achieved in the LIMA-LAD anastomosis.

angioplasty (PTCA) was performed on this segment (Fig. 2c). After this procedure, the patient's symptoms regressed and he was discharged.

DISCUSSION

Although the fine branches of IMA have a low potential to cause myocardial ischemia, larger side branches can cause significant myocardial ischemia when they are not bound during CABG procedure. Because the LIMA and its branches have a lower endurance compared to coronary vessels, these unbound large side branches can give rise to coronary steal syndrome. Unligated large side branches of the LIMA have the potential to cause angina following coronary artery surgery, and occlusion of these branches can abolish angina successfully.^[3] In obese patients, and in cases in which the cardiac surgeon is inexperienced, LIMA side branch harvesting and branch ligation success is low.^[4] When compared with the conventional method, unligated LIMA side branch is more often seen in minimal invasive CABG.^[5] In the literature, TIMI frame count among patients with unligated side branches and with bypass is lower and more ischemia is observed in their myocardium scintigraphy.^[6] On the other hand, there are data which do not confirm each other in the essays evaluating intravascular flow.^[7,8]

Unfortunately, little is known about long-term follow-up of occluded LIMA side branches which cause coronary steal syndrome. Each of the various methods used to occlude these side branches has advantages, disadvantages and varying indications. Repeating surgery to ligate a large branch vessel may damage the

IMA graft, and thus percutaneous methods are preferred.^[9] In the literature, there is no large series on occluded IMA side branches causing coronary steal phenomena. In most of the published case reports, coil occlusion is the method of choice. Eisenhauer et al. stated that the use of large numbers of small synthetic fiber coils in place of 1–2 coils may be more successful because of enhanced early thrombogenic activity.^[10] With the same intention, we used four 2 mm/2 cm coils in our case. The reason for recanalization in the case presented could be that a number of long coils were used. Normally, coils should form a spiral structure when they are released. When they are used in the treatment of aneurysms, they may easily become convoluted. In regular vascular structures, if the optimum coil diameter is not chosen, the coil cannot form a spiral shape and remains linearly inside the vessel. We consider this situation as a mechanism which can clarify the recanalization process in cases treated with coil occlusion.

The literature does not contain any prospective or retrospective trials concerning the recanalization rates of occluded IMA side branches. The number of published case reports is scarce. Although involving a different occluded artery, Enriquez et al. found a recanalization rate of 20.4% in 142 patients with an occluded gastro duodenal artery (GDA). They found the distance between exit of the GDA and the coil to be an important predictor of recanalization.^[11]

In light of present data, the potential factors for recanalization in occluded IMA side branches are distance between the coil and exit of the vessel, the number of coils used and the coil diameters and features.

Another treatment option for occlusion of IMA side branches is the use of stent grafts. While procedural success rates are high, restenosis is an important problem in follow-up. There is insufficient data on the long-term results of Jostent CSGs. In Gercken U et al., in which a Jostent CSG was used in different clinical cases, the restenosis rate was determined as 31.6% in a mean follow-up of 159 days.^[12]

In long-term follow-up studies of stent grafts, restenosis rates were determined as high. However, in most of the cases, the grafts were applied to the atherosclerotic segment. In the present case, the graft stent was implanted into a non-atherosclerotic stratum. Ten years after implantation, no restenosis was found in the graft stent, whereas the bare metal stent in the anastomosis site developed severe restenosis (90%) during this time period. Although data are insufficient, the usage of stent grafts is an alternative for use in occlusion of IMA side branches.

Another choice for treatment is occlusion using the AVP. In one reported case, occlusion of the LIMA side branch with AVP was successful during 4 years of follow-up.^[13] Zhu et al. investigated the results of coil occlusion versus AVP for splenic artery embolization. They found that in AVP usage, device migration, radiation dosage and cost were significantly lower. The span of occlusion and procedure were also lower.^[14]

Pech et al. compared AVP II with a platinum-fibered microcoil in gastroduodenal artery embolization. In AVP II usage, the total time of fluoroscopy and embolization were determined as significantly lower. In follow-up, in one case coil migration occurred, and in one coil case there was recanalization. The AVP II method was described as fast, easy and quite effective. The limiting feature was procedural difficulty in an angled vessel. They reported an average vessel diameter of 3.7 mm in their patients.^[15]

Considering the results of the two cases presented here and others in the literature, we suggest that the use of vascular plugs in IMA side branch occlusion may be effective due to shorter operation time, lower radiation rates and lower risk of recanalization. However, one main disadvantage of this treatment is the large plug size. Presently, the smallest commercially available vascular plug size is 4 mm. If these devices are to be 30-50% larger than vessel diameter, then the latter should not exceed approximately 2.7 mm. Production of smaller devices may make IMA

side branch occlusion more successful and provide long-term success. Considering the diameters of IMA side branches, available AVPs do not appear to be the right choice in most cases.

To conclude, coil occlusion of IMA side branches is the most widely used method. Although data is limited on stent grafts for occlusion of IMA side branches, they may be hopeful. With a new generation of smaller and more flexible AVP devices, they may become more commonly, and successfully, deployed. In order to establish the best treatment option, we need more data based on large size clinical trials and longer follow-ups.

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REFERENCES

1. Loop FD, Lytle BW, Cosgrove DM, Stewart RW, Goormastic M, Williams GW, et al. Influence of the internal-mammary-artery graft on 10-year survival and other cardiac events. *N Engl J Med* 1986;314:1–6. [CrossRef](#)
2. Sbarouni E, Corr L, Fenech A. Microcoil embolization of large intercostal branches of internal mammary artery grafts. *Cathet Cardiovasc Diagn* 1994;31:334–6. [CrossRef](#)
3. Singh RN, Magovern GJ. Internal mammary graft: improved flow resulting from correction of steal phenomenon. *J Thorac Cardiovasc Surg* 1982;84:146–9.
4. Hijazi A, Mazhar R, Odeh S, Quinnaby I. Coronary steal through anomalous internal mammary artery graft. Treated by ligation without sternotomy. *Tex Heart Inst J* 1996;23:226–8.
5. Sarzaeem MR, Sandoughdar S, Peyvandi H, Nazparvar B, Mirhoseini SM, Mandegar MH. Comparison of endoscopic versus conventional internal mammary harvesting regarding unligated side branches. *Kardiol Pol* 2013;71:595–9. [CrossRef](#)
6. Biceroglu S, Karaca M, Yildiz A, Ildizli Demirbas M, Yilmaz H. Can left internal mammary artery side branches affect blood flow rate? *Cardiovasc J Afr* 2009;20:119–21.
7. Guzon OJ, Klatte K, Moyer A, Khouraz S, Kern MJ. Fallacy of thoracic side-branch steal from the internal mammary artery: analysis of left internal mammary artery coronary flow during thoracic side-branch occlusion with pharmacologic and exercise-induced hyperemia. *Catheter Cardiovasc Interv* 2004;61:20–8. [CrossRef](#)
8. Morocutti G, Gasparini D, Spedicato L, Gelsomino S, Paparella G, Bernardi G, et al. Functional evaluation of steal by unligated first intercostal branch before transcatheter embolization in recurrent angina after a LIMA-LAD graft. *Catheter Cardiovasc Interv* 2002;56:373–6. [CrossRef](#)
9. Wolfenden HD, Newman DC. Avoidance of steal phenomena by thorough internal mammary artery dissection. *J Thorac Cardiovasc Surg* 1992;103:1230–1.

10. Eisenhauer MD, Mego DM, Cambier PA. Coronary steal by IMA bypass graft side-branches: a novel therapeutic use of a new detachable embolization coil. *Cathet Cardiovasc Diagn* 1998;45:301–6. [CrossRef](#)
11. Enriquez J, Javadi S, Murthy R, Ensor J Jr, Mahvash A, Abdelsalam ME, et al. Gastroduodenal artery recanalization after transcatheter fibered coil embolization for prevention of hepaticoenteric flow: incidence and predisposing technical factors in 142 patients. *Acta Radiol* 2013;54:790–4. [CrossRef](#)
12. Gercken U, Lansky AJ, Buellesfeld L, Desai K, Badereldin M, Mueller R, et al. Results of the Jostent coronary stent graft implantation in various clinical settings: procedural and follow-up results. *Catheter Cardiovasc Interv* 2002;56:353–60.
13. Yorgun H, Canpolat U, Kaya EB, Çil B, Aytemir K, Oto A. The use of Amplatzer Vascular Plug(®) to treat coronary steal due to unligated thoracic side branch of left internal mammary artery: four year follow-up results. *Cardiol J* 2012;19:197–200. [CrossRef](#)
14. Zhu X, Tam MD, Pierce G, McLennan G, Sands MJ, Lieber MS, et al. Utility of the Amplatzer Vascular Plug in splenic artery embolization: a comparison study with conventional coil technique. *Cardiovasc Interv Radiol* 2011;34:522–31. [CrossRef](#)
15. Pech M, Kraetsch A, Wieners G, Redlich U, Gaffke G, Ricke J, et al. Embolization of the gastroduodenal artery before selective internal radiotherapy: a prospectively randomized trial comparing platinum-fibered microcoils with the Amplatzer Vascular Plug II. *Cardiovasc Interv Radiol* 2009;32:455–61. [CrossRef](#)

Keywords: Amplatzer vascular plug; coil; internal mammarian artery; stent; subclavian steal syndrome.

Anahtar sözcükler: Amplatzer vascular plug; coil; internal mammary arter; stent; subklavyen çalma sendromu.