Internal thoracic artery-inferior epigastric artery as a collateral pathway in aortoiliac occlusive disease

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Objective: **In patients with aortoiliac occlusion, the internal thoracic artery-inferior epigastric artery (ITA-IEA) collateral is one of the collaterals supplying blood flow to the lower extremity, and the interruption of this collateral may cause severe leg ischemia. The aim of this study was to evaluate by color duplex ultrasonography scans the ITA-IEA pathway and its significance as a collateral in providing lower-extremity perfusion in aortoiliac occlusive disease.**

Methods: **Color duplex ultrasonography scans were prospectively performed in 64 consecutive patients with aortoiliac occlusion. Blood flow measurement in the ITA, IEA, and common femoral artery was done on both sides. The patients were stratified according to occlusion level (aorta, common iliac artery, external iliac artery), and the data obtained from such groups were compared.**

Results: **In 95% of patients with aortoiliac occlusion, the ITA-IEA pathway was functioning as a collateral, with mean collateral flow of 66 ± 48 mL/min, and its average contribution to lower-extremity perfusion was 38% ± 23%. Additionally, a moderately positive correlation was found between flows of ITA and IEA ($r = 0.55$, $P < .0001$). Depending on the level of occlusion, the collateral flow and its contribution to perfusion progressively decreased from the proximal to distal aortoiliac occlusion level. Furthermore, the difference in the ITA-IEA flow volume was statistically significant between occlusion levels ($P = .009$), but the differences in the perfusion contribution were not different among levels ($P = .311$). There was also no statistical difference between the groups concerning collateral flow volume and contribution to lower-extremity perfusion in relation to unilateral or bilateral occlusion of the iliac artery, the state of distal run-off being good or poor, or the clinical findings being mild or severe.**

Conclusion: **In patients with aortoiliac occlusion, the ITA-IEA collateral pathway is an important route providing lower-extremity perfusion. Additionally, Doppler sonographic flow measurements of the contribution of the ITA-IEA route to lower-extremity perfusion may provide beneficial diagnostic information necessary for the pretreatment work-up of patients with aortoiliac occlusion, especially for whom the ITA is planned to be used as a coronary artery graft. (J Vasc Surg 2006;43:707-13.)**

The internal thoracic artery (ITA), also known as the internal mammary artery, is the conduit of choice for coronary artery bypass grafting (CABG) and is routinely used in many institutions. However, because the ITA can be a major collateral pathway to lower limbs in patients with aortoiliac artery occlusive disease, the use of the ITA for myocardial revascularization may be associated with severe leg ischemia.[1-5] Doppler ultrasonography scanning, which is a noninvasive and easily available method, can determine not only the existence of this collateral but also its contribution in the blood supply to the lower limb. The aim of this study was to prospectively evaluate the internal thoracic artery-inferior epigastric artery (ITA-İEA) pathway as a collateral in providing lower-extremity perfusion in patients with aortoiliac occlusive disease as assessed by color duplex ultrasonography (CDU) scanning.

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MATERIALS AND METHODS

From May 2002 to September 2004, we prospectively examined all patients referred for CDU scans of the aorta and peripheral arterial system of the lower extremities. Patients who had evidence of complete occlusion of aorta or iliac arteries on CDU examination were selected for our study. There were 60 men and 4 women with a mean age of 62 years (range, 34 to 79 years). Fifty-six patients had intermittent claudication, three had rest pain, and five had ischemic ulceration on the legs. Patients were excluded from this study if they had (1) occlusion of a common femoral artery (CFA), (2) previously undergone surgical revascularization or other interventional treatment of the lower-extremity arteries, (3) an ITA previously used as a conduit for CABG, or (4) a lower-extremity amputation. All patients gave oral informed consent. The institutional review board approved the study.

After 15 minutes of rest in the supine position, spectral Doppler velocity waveform and diameter measurements were obtained from ITA, IEA, and common femoral artery (CFA). The ITA was evaluated by using a parasternal approach in a parasagittal plane at the level of second intercostal space. The examination to find the origin of the IEA began at the level of the CFA in a transverse plane, and moving superiorly, the origin of the IEA was identified about 1 to 2 cm above the inguinal ligament. The IEA and its accompanying vein were localized just posterior of the rectus abdominis muscle. The course of the IEA was then followed longitudinally. The IEA was distinguished from the accompanying vein by the presence of an arterial Doppler signal.

To prevent errors in velocity measurement, Doppler samples in the IEA were obtained in the proximal 2 to 4 cm of the artery where it can be followed as a straight tubular structure. When the flow in IEA was in a cranial direction it was considered normal flow, and when it was in a caudal direction it was assumed to be reverse flow.

Flow measurements in CFA were made 1 to 2 cm above the origin of the deep femoral artery. When flow in a reverse direction (flow in cranial direction) was determined in the deep femoral artery, measurements were made at the proximal superficial femoral artery to add the contribution of the collateral flow that develops through the deep femoral artery.

All CDU examinations were performed by the same experienced radiologist (M. T.), who was not aware of the level of arterial occlusion. CDU examinations were performed with the GE Logiq 700 (General Electric Company, Milwaukee, Wis) equipped with a 5- to 10-MHz linear-array transducer. The Doppler angle was kept at the 60° standard. Sample volume was expanded over the entire vessel diameter with the intention of including the slower flow near the vessel wall. A 3000-Hz pulse repetition frequency value was used as a default. The velocity scale was set according to peak systolic flow velocity. Inner diameters of the vessels were measured at the same site where the Doppler spectrum was obtained. The mean blood flow velocity (Vmean) and the blood flow were calculated automatically by using the built-in software of the equipment in use. Blood flow in mL/min was determined by using the formula: Vmean (in cm/s) × cross-sectional area of the vessel (in cm^2) × 60. The measurements of blood flow of the vessels were repeated at least three times and later averaged. All patients underwent digital subtraction arteriography ≤48 hours after the CDU examination. Digital subtraction arteriography was performed with a Polytron V 1000 angiographic unit (Siemens, Erlangen, Germany) by using a percutaneous transbrachial or transfemoral catheterization technique.

For statistical analysis, the right and left sides of each patient were accepted as separate cases. The level of aortoiliac occlusion was determined by angiography. The sides that did not show aortoiliac occlusion were included in the control group. The sides with aortoiliac stenosis were also included in the control group if no functioning ITA-IEA collateral was seen. The ITA flows of the control group and the group with aortoiliac occlusion and working ITA-IEA collaterals were compared. In addition, because important collaterals can develop from xiphoid branches between the right and left ITAs, ITA flows in sides with aortoiliac occlusion and in the counterlateral sides without aortoiliac occlusion were compared.

Reverse flow volume measured at the proximal IEA was defined as ITA-IEA collateral flow volume. CFA flow was defined as lower-extremity perfusion. The percentage contribution of the ITA-IEA collateral to lower-extremity perfusion was calculated using the formula: (IEA flow volume/CFA flow volume) × 100. Of the 128 sides in 64 patients, nine were excluded from final evaluation (4 had a CFA occlusion, 1 surgical revascularization, 2 amputation and 2 ITA graft). Images from one patient are shown in Fig 1.

The influence of four separate factors on ITA-IEA CFA Doppler flow data was examined:

1. levels of occlusion and refilling via collateral (abdominal aorta, common iliac artery, external iliac artery),
2. iliac artery occlusion as unilateral and bilateral,
3. state of distal run-off as good (distal arteries open) and poor (femoropopliteal occlusion or occlusion in at least two arteries in the calf), and
4. severity of clinical symptoms as mild (Fontaine 1 and 2A) and severe (Fontaine 2B to 4).

In each of the analyses, subgroups were compared in terms of flow volume in the ITA-IEA collateral and its contribution to the blood supply to the leg. The results are reported as mean ± SD. Flow measurements from defined groups were compared by Kruskal-Wallis one- way analysis of variance, the Mann-Whitney *U* test, and *t* tests. $P < .05$ was considered to be indicative of a statistical difference. Linear regression methods were used to analyze the relationships both between ITA and IEA flow, and between the contribution of the ITA-IEA collateral pathway to lower-extremity perfusion and its flow.

RESULTS

IEA flow was reversed (in a caudal direction) in 72 (95%) of 76 sides showing aortoiliac occlusion, normal in three sides (4%), and occluded in one side (1%). In contrast, IEA flow was normal (in a cranial direction) in 40 (93%) of 43 sides that did not show aortoiliac occlusion. Reverse flow was present in three sides (7%) without aortoiliac occlusion (aortic stenosis in 2; severe iliac stenosis in 1). Because the contribution of the ITA-IEA collateral was less in these three sides with aortoiliac stenosis where reverse flow was observed in the IEA compared with sides with aortoiliac occlusion (average flow was 43 mL/min and the proportion of contribution to lower-extremity perfusion was 11%), these three sides were not included in the study. In the remaining sides, the average ITA flow was 50 ± 28 mL/min in patients in the control group and 104 ± 52 mL/min in patients in the group with aortoiliac occlusion ($P < .0001$). Additionally, there was a statistically significant difference in ITA flow between the sides with unilateral iliac occlusion and the contralateral patent sides (87 ± 46 mL/min and 50 ± 28 mL/min, respectively; $P = .0002$).

In patients with aortoiliac occlusion, the mean ITA-IEA collateral flow was 66 ± 48 mL/min and its contribution to lower-extremity perfusion was 38% ± 23%. Furthermore, a moderately positive correlation was found between ITA flow and IEA flow ($r = 0.55$, $P < .0001$) (Fig 2), and local linear regression showed a relationship between the pro-

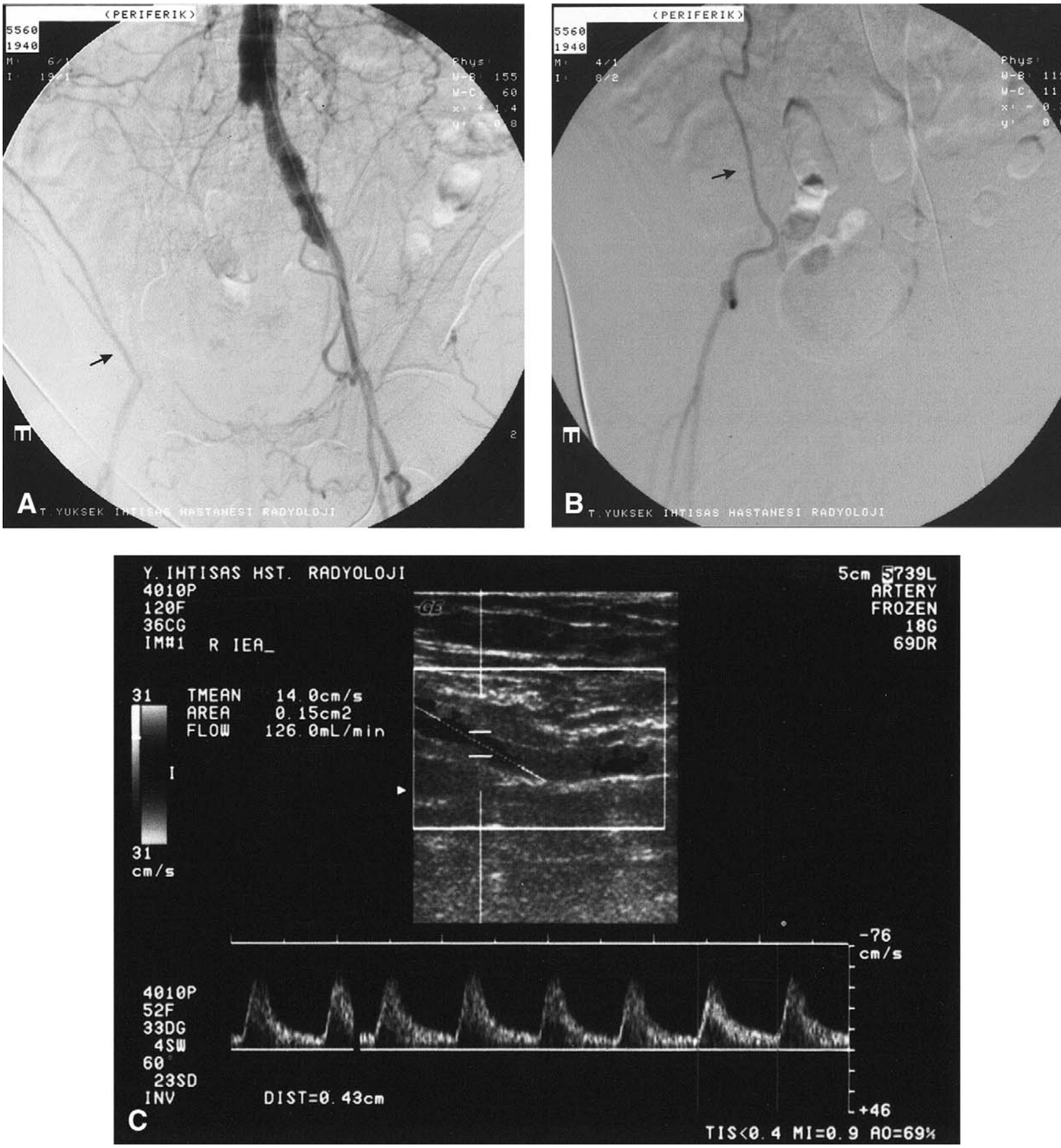

Fig 1. Right common iliac artery occlusion in a 65-year-old man. **A,** Abdominal aortogram reveals occlusion of right common iliac artery. There is faint reconstitution of the distal external iliac artery on the right via the deep circumflex iliac artery *(arrow)* that is due to partial washout of contrast material by unopacified blood from the ipsilateral of the internal thoracic artery-inferior epigastric artery (ITA-IEA) collateral. **B,** Selective angiography of the right subclavian artery demonstrates anastomosis between the ITA-IEA *(arrow)* via the superior epigastric artery, reconstituting the right external iliac artery. **C,** Color duplex ultrasonography shows monophasic spectral pattern in the IEA. The flow was measured as 126 mL/min in the IEA and 262 mL/min in the femoral artery, the contribution of the ITA-IEA collateral to lower-extremity perfusion is calculated to be 48%.

portion of the contribution of the ITA-IEA collateral to lower-extremity perfusion and the ITA-IEA flow (Fig 3). Additionally, as seen on the graph, the flow volume of the ITA-IEA collateral increased linearly up to a 50% level of contribution to lower-extremity perfusion (85 mL/min), but after that level, it showed almost no change.

Mean flow volumes of the ITA and IEA decreased according to the level of occlusion (aorta, common iliac

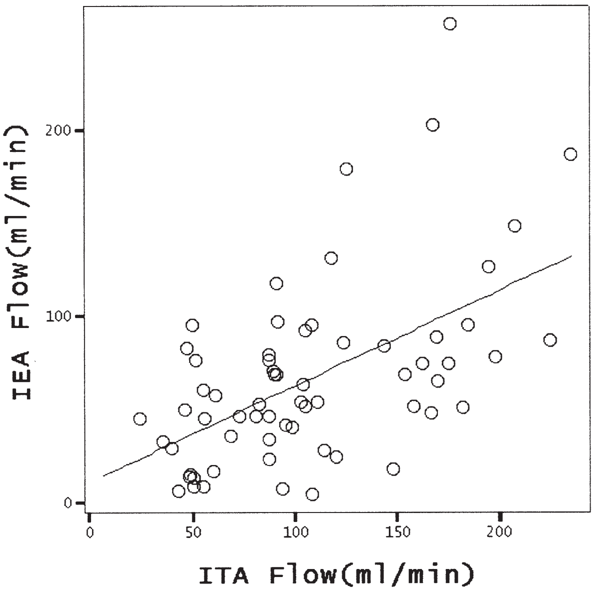

Fig 2. Correlation between internal thoracic artery *(ITA)* and inferior epigastric artery *(IEA)* blood flow ($r = 0.55$, $P < .0001$).

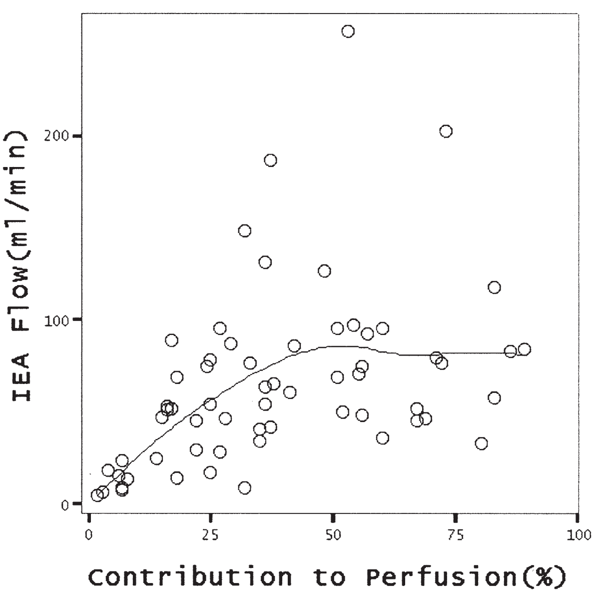

Fig 3. Scattergram illustrates the proportion of contribution of the internal thoracic artery (ITA)-inferior epigastric artery *(IEA)* collateral pathway to lower-extremity perfusion vs ITA-IEA flow. Local linear regression curve indicates that mean maximum flow is 85 mL/min.

artery, external iliac artery) from proximal to distal, and there were statistically significant differences between flow volumes at each of these levels ($P = .0001$ and $P = .009$, respectively) (Table I, Fig 4). In contrast, although the contribution of the ITA-IEA collateral flow to lower-extremity perfusion also decreased from the proximal to distal level of aortoiliac occlusion, the difference between the levels was not significant ($P = .311$) (Table I, Fig 5). There was also no statistically significant difference between the occlusion levels concerning collateral flow volume and the contribution to lower-extremity perfusion (Table II). Similarly, collateral flow volume and contribution to lower-extremity profusion were not significantly different when unilateral vs bilateral occlusion of the iliac arteries, the state of distal run-off being good or poor, or the clinical findings being mild or severe were considered.

DISCUSSION

In aortoiliac occlusive disease, various collateral pathways maintain blood flow to the lower extremities.[6-12] The ITA-IEA pathway is one of these collaterals, but it may easily be overlooked owing to its origin distant from the aortoiliac segment. This collateral pathway involves the ITA arising from the first part of subclavian artery connecting through the superior epigastric artery and the IEA and eventually to the external iliac artery (Fig 6). Because the ITA is extensively used for CABG in patient populations at high risk for associated atherosclerotic peripheral arterial disease, preoperative evaluation of this collateral pathway is of significant importance.

Interruption of critical collaterals from ITA is considered to be a major cause of acute limb-threatening ischemia in patients with aortoiliac occlusive disease.[2,3] Acute limb ischemia has also been reported in patients with aortoiliac occlusive disease after CABG.[1-5] Acute limb-threatening ischemia after cardiac operations may result from events such as insufficient perfusion during cardiopulmonary bypass, low cardiac output in the postoperative period, overuse of vasopressors, atheromatous embolization, postoperative thrombosis, and interruption of the ITA collateral pathway.[3] Additionally, using the epigastric artery as flap in reconstructive surgery and performing a transverse abdominal incision in nonvascular procedures, which interrupts the epigastric arteries, may result in serious leg ischemia for patients with aortoiliac occlusion.[4,11,13]

When patients with aortoiliac disease are selected for CABG, selective ITA angiography or Doppler evaluation of the IEA likely should be done to assess the condition of the ITA and IEA as a potential collateral pathway to the lower extremity.[2,13-16] On angiography, if ITA is found to be the collateral to the ipsilateral external iliac artery or if there is Doppler evidence of reversal of IEA flow, it is recommended to avoid the use of the ITA or to perform a sequential or staged revascularization of coronary and peripheral arteries. However, opacification of the external iliac artery by the ITA-IEA collateral route on angiography or the presence of reverse flow in the IEA on Doppler only indicates that the ITA-IEA collateral is functioning, and these findings do not give information about the amount of collateral contribution to lower-extremity perfusion.

To our knowledge, no detailed study up to now has evaluated the contribution of ITA-IEA collateral to lower-extremity perfusion in aortoiliac occlusion. In our study, the contribution of this collateral to lower-extremity per-

Table I. Mean flow volume of the ITA and İEA in aortoiliac occlusive disease and the ITA-IEA collateral pathway percentage contribution to lower-extremity perfusion

	Aortic occlusion (n = 28)	*CIA occlusion (n = 27)*	*EIA occlusion (n = 17)*	*Control (n = 40)*	P
ITA flow volume (mL/min)	131 ± 56	94 ± 43	71 ± 28	50 ± 28	.0001
IEA flow volume (mL/min)	85 ± 58	59 ± 34	39 ± 32	—	.009
Contribution to lower-extremity perfusion (%)	42 ± 24	37 ± 20	32 ± 28	—	.311

ITA, Internal thoracic artery; *IEA,* inferior epigastric artery; *CIA,* common iliac artery; *EIA,* external iliac artery.

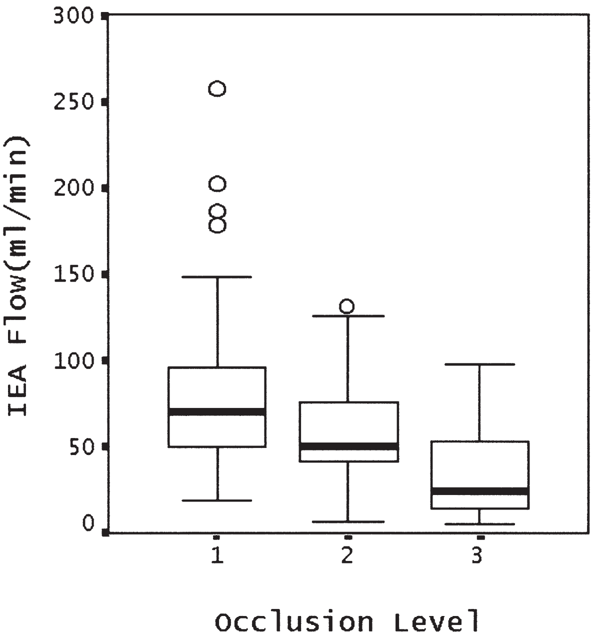

Fig 4. Graph shows the flow in the internal thoracic artery-inferior epigastric artery *(IEA)* collateral according to their level of occlusion (1-abdominal aorta, 2-common iliac artery, 3-external iliac artery). The *o* shows the extremes of the data.

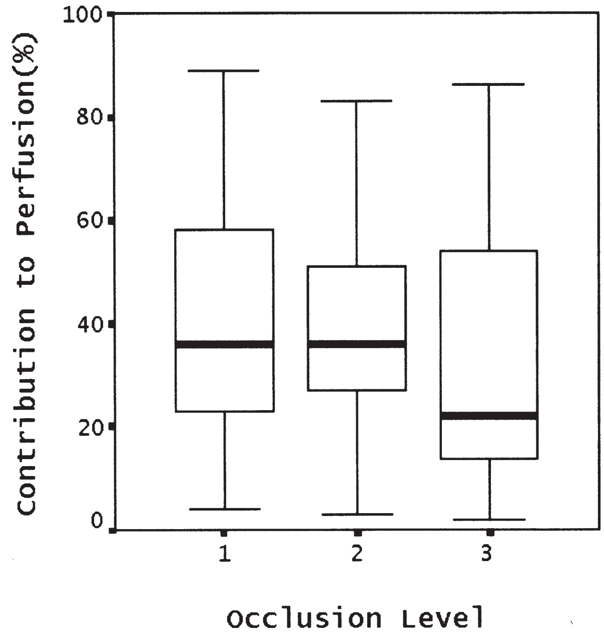

Fig 5. Graph shows the proportion of contribution of the internal thoracic artery-inferior epigastric artery collateral pathway to lower-extremity perfusion according to their level of occlusion (1-abdominal aorta, 2-common iliac artery, 3-external iliac artery). Whiskers represent median ± SD.

fusion was quantitatively determined by Doppler flow measurement. This study showed that the average flow volume and contribution of the ITA-IEA collateral to lower-extremity perfusion was 66 ± 48 mL/min and 38% ± 23%. Additionally, this collateral pathway was open in 99% of patients with aortoiliac occlusion and was functioning as a collateral pathway in 95%. Thus, this collateral pathway, which is less affected by atherosclerosis compared with the other potential collateral networks, becomes potentially significant in a patient with aortoiliac occlusive disease that is a candidate for CABG.

The contribution of this collateral to lower-extremity perfusion is limited (maximum 85 mL/min), however. The main reason for this limitation is likely the high resistance that is caused by the collateral pathway being rather long and the existence of a thin vessel network between the superior and inferior epigastric arteries. The flow in this collateral becomes reversed only in a severe or complete aortoiliac obstruction. For this reason, Doppler determination of flow direction can be used as screening test for aortoiliac obstruction.[17]

Our study has some limitations, one of which is the assumption that the CFA supplies the entire lower-extremity blood flow. The other limitation is that the study was based on Doppler flow measurement. Doppler flow measurements are known to be prone to variability. Small changes in diameter measurement and Doppler angle estimation can lead to non-neglectable errors in blood flow measurement. Blood flow measurement using Doppler is also influenced by many environmental factors such as systemic blood pressure, temperature, and heart beat rate. To limit the influence of these factors in our study, in addition to absolute blood flow measurement of the ITA-IEA collateral, the proportion of contribution to low-extremity perfusion was calculated and evaluated.

In this study, the ITA-IEA collateral that develops in patients with aortoiliac occlusion was examined, but other

Table II. Comparison of groups according to their angiographic and clinical findings

	IEA flow volume (mL/min)	*Contribution to lower-extremity perfusion (%)*
Iliac occlusion		
Unilateral	54 ± 34	35 ± 23
Bilateral	58 ± 33	22 ± 17
	P = .599	*P* = .139
Distal run-off		
Good	61 ± 47	37 ± 24
Poor	69 ± 45	40 ± 20
	P = .563	*P* = .529
Clinical finding		
Mild	73 ± 51	38 ± 22
Severe	49 ± 38	36 ± 25
	P = .082	*P* = .659

IEA, Inferior epigastric artery.

collaterals were not. It is obvious, however, that an interaction occurs between the collaterals that provide lower-extremity perfusion. If the other collaterals are well developed, then the flow of the ITA-IEA collateral will be less effective in supplying perfusion to the lower extremities. This study found that the contribution of the ITA-IEA collateral pathway to lower-extremity perfusion was higher in the section of proximal aortoiliac occlusion compared with distal occlusion, and this can be partially explained by the fact that in proximal occlusion, more distal collaterals cease to function. In other words, the ITA-IEA collateral pathway appears more important in aortic and common iliac arterial occlusion, but in external iliac artery occlusions, the hypogastric collateral route likely has a high flow rate.

This study was not done with the aim of determining the threshold amount of collateral flow that would result in severe leg ischemia after the interruption of the ITA-IEA collateral. However, in a patient with aortoiliac occlusion, if the ITA is used as a graft, the risk of acute ischemia developing in the lower extremity is expected to increase with the direct proportion of the ITA-IEA collateral contribution to lower-extremity perfusion. This is because when the ITA is used as a graft, its function as a collateral would be disrupted, and if it is a major collateral, then the other secondary collaterals, whose contributions are likely very low, would not compensate for the interrupted flow of ITA-IEA collateral route. Therefore, during the work-up of patients with aortoiliac occlusion who require CABG, not only should the absolute quantity of the flow of this collateral to lower extremity be assessed but also its contribution to lower-extremity perfusion.

Although differences were noted in terms of ITA-IEA collateral flow according to the levels of aortoiliac occlusion, there was also a significant overlap in flow volume between these groups. And, still more important, no significant differences were found in the proportion of contribution to lower-extremity perfusion. Furthermore, there were no differences in flow volume or contribution to

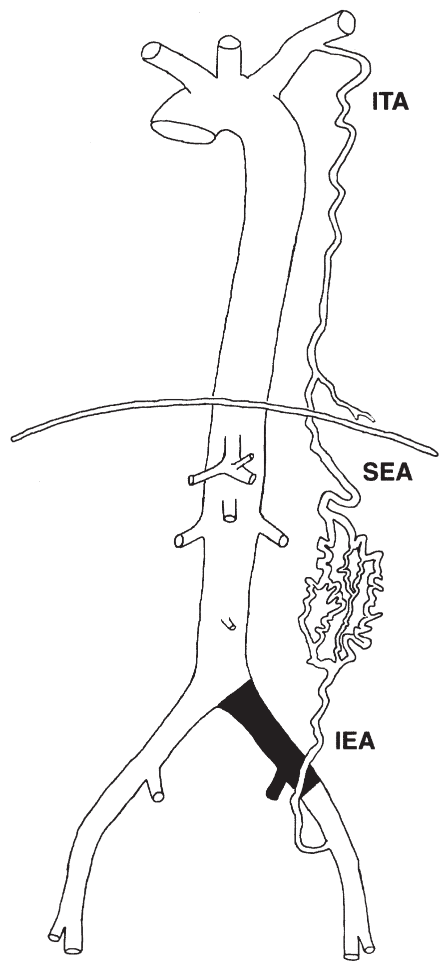

Fig 6. Schematic view of the collateral circulation via the internal thoracic and epigastric arteries in occlusion of the left common and external iliac arteries. *ITA,* Internal thoracic artery; *SEA,* superior epigastric artery; *IEA,* inferior epigastric artery.

perfusion according to differences in the clinical findings and distal run-off. Therefore, for the management an individual patient with aortoiliac occlusion, there do not appear to be clinical predictors of the importance of the ITA-IEA pathway, and the contribution of this collateral to lower-extremity perfusion should be evaluated before CABG. Angiography may be used at this step; however, CDU evaluation has some convincing advantages, such as its ability to provide objective hemodynamic data regarding the flow direction, flow volume, and perfusion.

CONCLUSION

In aortoiliac occlusion, the ITA-IEA collateral pathway is an important route providing lower-extremity perfusion. Doppler sonographic flow measurements of the contribution of the ITA-IEA route to lower-extremity perfusion may provide beneficial diagnostic information necessary for pretreatment evaluation of the patients with aortoiliac occlusion, especially those for whom the ITA is planned to be used as a graft.

AUTHOR CONTRIBUTIONS

Analysis and interpretation: MY, MT, EÖ, MB, TC
Data collection: MY, MT, EÖ, MB
Writing the article: MY, MT
Critical revision of the article: MY, MT, EÖ, MB, TC
Final approval of the article: MY, MT, EÖ, MB, TC
Statistical analysis: MY, MT
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Overall responsibility: MY

REFERENCES

1. Melissano G, Di Credico G, Chiesa R, Grossi A. The use of internal thoracic arteries for myocardial revascularization may produce acute leg ischemia in patients with concomitant Leriche's syndrome. J Vasc Surg 1996;24:698.
2. Dietzek AM, Goldsmith J, Veith FJ, Sanchez LA, Gupta SK, Wengerter KR. Interruption of critical aortoiliac collateral circulation during non-vascular operations: a cause of acute limb-threatening ischemia. J Vasc Surg 1990;12:645-51; discussion, 652-3.
3. Kitamura S, Inoue K, Kawachi K, Morita R, Seki T, Taniguchi S, et al. Lower extremity ischemia secondary to internal thoracic-coronary artery bypass grafting. Ann Thorac Surg 1993;56:157-9.
4. Tsui SS, Parry AJ, Large SR. Leg ischaemia following bilateral internal thoracic artery and inferior epigastric artery harvesting. Eur J Cardiothorac Surg 1995;9:218-20.
5. Yapici F, Tuygun AG, Tarhan IA, Yilmaz M, Tuygun AK, Yapici N, et al. Limb ischemia due to use of internal thoracic artery in coronary bypass. Asian Cardiovasc Thorac Ann 2002;10:254-5.
6. Figley MM, Muller RF. The arteries of the abdomen, pelvis, and thigh. I. Normal roentgenographic anatomy. II. Collateral circulation in obstructive arterial disease. Am J Roentgenol Radium Ther Nucl Med 1957;77:296-311.
7. Bron KM. Thrombotic occlusion of the abdominal aorta. Associated visceral artery lesions and collateral circulation. Am J Roentgenol Radium Ther Nucl Med 1966;96:887-95.
8. Caresano A. The collateral circulation in chronic occlusions of the abdominal aorta and of its terminal branches (anatomo-radiological discussion). J Cardiovasc Surg (Torino) 1966;7:297-310.
9. Edwards EA, Lemay M. Occlusion patterns and collaterals in arteriosclerosis of the lower aorta and iliac arteries. Surgery 1955;38:950-63.
10. Chait A. The internal mammary artery: an overlooked collateral pathway to the leg. Radiology 1976;121:621-4.
11. Krupski WC, Sumchai A, Effeney DJ, Ehrenfeld WK. The importance of abdominal wall collateral blood vessels. Planning incisions and obtaining arteriography. Arch Surg 1984;119:854-7.
12. Kim J, Won JY, Park SI, Lee do Y. Internal thoracic artery collateral to the external iliac artery in chronic aortoiliac occlusive disease. Korean J Radiol 2003;4:179-83.
13. Hodge K, Yuen J, Moursi M, Eidt JF. Critical leg ischemia resulting from interruption of collaterals by harvest of the rectus abdominis free flap: endovascular salvage. Ann Plast Surg 2000;45:427-30.
14. Arnold JR, Greenberg JD, Clements S. Internal mammary artery perfusing the Leriche's syndrome. Ann Thorac Surg 2000;69:1244-6.
15. Shimizu T, Hirayama T, Ikeda K, Ito S, Ishimaru S. Coronary revascularization with arterial conduits collateral to the lower limb. Ann Thorac Surg 1999;67:1783-5.
16. Parashara DK, Kotler MN, Ledley GS, Yazdanfar S. Internal mammary artery collateral to the external iliac artery: an angiographic consideration prior to coronary bypass surgery. Cathet Cardiovasc Diagn 1994; 32:343-5.
17. Kwaan JH, Connolly JE. Doppler assessment of the inferior epigastric artery flow patterns as a screening test for aortoiliac obstruction. Am J Surg 1979;137:250-1.

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