# Application of the descending branch of the lateral circumflex femoral artery in coronary artery bypass grafting



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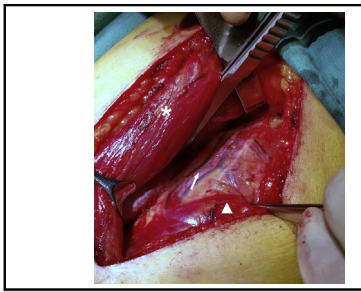
## ABSTRACT

**Objective:** To investigate a technical method for harvesting and using the descending branch of the lateral circumflex femoral artery (DLCFA) in coronary artery bypass grafting (CABG).

**Methods:** Between January 2017 and January 2019, 40 patients (36 in the planed selection group and 4 in the temporary decision group) with mean age of 49.1 ± 7.5 years received DLCFA as an arterial conduit in CABG. In all patients, the DLCFA was successfully harvested via an anterior thigh incision. Depending on the location of the target vessel, the DLCFA was used as a free graft or a composite graft.

**Results:** Of the 44 patients in the planned selection group, DLCFA harvesting was abandoned in 8 patients because computed tomographic angiography revealed anatomical variation or stenosis of the superficial femoral artery. Of the 5 patients in the temporary decision group, harvesting was abandoned in 1 because of short length and thin caliber. On an average, 3.7 ± 0.9 distal anastomoses were created during CABG, with no adverse effects. The length of the harvested DLCFA was 9.9 ± 1.7 cm, with an average proximal lumen diameter of 3.4 ± 0.7 mm. The DLCFA was used as a free graft in 26 patients and as a "Y"-shape composite graft in 14 patients. Total arterial CABG was performed in 75% of the patients.

**Conclusions:** The DLCFA is an alternative conduit for CABG. It can be harvested easily and safely. However, preoperative computed tomographic angiography examination is necessary for the smooth application of the DLCFA, and an appropriate strategy for graft establishment should be considered. (J Thorac Cardiovasc Surg 2021;161:1266-71)



Anatomic position of the descending branch of the lateral circumflex femoral artery.

**Central Message**

This study was an investigation of a technical method for harvest and use of the descending branch of the lateral circumflex femoral artery (DLCFA) in coronary artery bypass grafting (CABG).

**Perspective**

The descending branch of the lateral circumflex femoral artery is an arterial graft and has a certain rate of abandonment because of anatomical variation and short length. In this study, we focused on improving the application of this conduit using preoperative multidetector computed tomographic angiography screening and on the establishment of appropriate strategies for bypass grafting.

See Commentaries on pages 1272 and 1273.

Coronary artery bypass grafting (CABG) is an important treatment for coronary atherosclerotic heart disease. The great saphenous vein (SVG), internal thoracic artery (ITA), and radial artery (RA) are commonly used for grafting in CABG. Although the SVG is usually easily harvested and sufficient length is obtained, the long-term patency rate is unsatisfactory. The patency rate of arterial material graft is considered superior to that of the SVG.[1,2] However, due to

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Received for publication June 3, 2019; revisions received Sept 10, 2019; accepted for publication Sept 11, 2019; available ahead of print Oct 24, 2019.

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0022-5223/$36.00



https://doi.org/10.1016/j.jtcvs.2019.09.172

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**Abbreviations and Acronyms**

CABG = coronary artery bypass grafting
CTA = computed tomographic angiography
DLCFA = descending branch of the lateral circumflex femoral artery
ITA = internal thoracic artery
LCFA = lateral circumflex femoral artery
LITA = left internal thoracic artery
RA = radial artery
RITA = right internal thoracic artery
SVG = great saphenous vein

limited source material, arterial grafts are often unable to meet the needs of treatment of multivessel disease. Therefore, the search for more suitable arterial graft material has attracted considerable interest on the part of cardiac surgeons. The descending branch of the lateral circumflex femoral artery (DLCFA) is an arterial graft derived from the lower extremities that can be used in CABG.[3,4] The clinical study[5] shows that the DLCFA has a certain rate of abandonment because of the presence of an anatomical variation and short length for use. Therefore, in this study, we focused on improving the application of this conduit using preoperative multidetector computed tomographic angiography (CTA) screening and on the establishment of appropriate strategies for bypass grafting.

## METHODS

Between January 2017 and January 2019, 40 patients (mean age 49.1 ± 7.5 years, 35 male) underwent CABG using DLCFA as the arterial conduit during operation in Fuwai Hospital. The 40 patients were divided into 2 groups, namely, the planned selection group (n = 36) and the temporary decision group (n = 4).

During the study period, consecutive patients younger than 60 years of age in one ward requiring CABG were enrolled into the planned selection group. A total of 44 patients (39 male and 5 female) were selected with mean age 48.6 ± 7.7 years. All underwent CTA screening for bilateral DLCFA. If CTA showed that the DLCFA was clear, in a normal anatomical position, and the length of the vessel segment above the diameter of 1.5 mm was longer than 10 cm, the DLCFA was considered to be an accessible conduit material. Patients with occlusive lesions in the superficial femoral artery were also excluded by CTA examination. If bilateral DLCFAs were asymmetrical, the dominant side was harvested. Otherwise, the left-sided DLCFA was obtained to facilitate surgery.

In 5 male patients (mean age 52.0 ± 1.0 years), the DLCFA was temporarily determined to be harvested during CABG because of lack of sufficient conduit materials. In these patients, the left-sided DLCFA was obtained.

CABG was performed in the regular fashion. It was left up to the operator to determine the on-pump or off-pump mode to complete the operation. Total or multiple (more than 2 arterial conduits) arterial revascularization strategies were adopted. Therefore, the RA and the bilateral ITA would be used according to the individual plan for the patient.

Routine oral calcium antagonists were prescribed for the first 3 months after surgery. All patients underwent follow-up. Coronary artery CTA was planned to evaluate graft patency for every patient at 1 year and 3 years after surgery.

Quantitative data were expressed as mean ± standard deviation, and discontinuous values were presented as percentages. All data analyses were performed using the Statistical Package for the Social Sciences (version 17.0; SPSS Inc, Chicago, Ill).

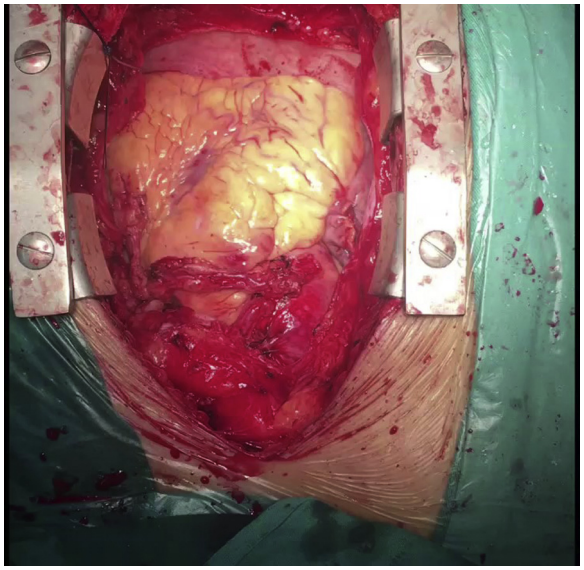
### CTA Screening Technique for DLCFA

Technologists completed centralized training to ensure uniform compliance with the multidetector CTA protocol, as monitored throughout the study. All patients provided informed consent, and the study was performed according to the guidelines of the ethics committee of Fuwai Hospital. CTA screening was performed using prospective acquisition electrocardiographic gating with 700-millisecond gantry rotation, 100-kV tube voltage, and 200-mA tube current on a GE Discovery CT750HD (GE Healthcare, Chicago, Ill). A total of 80 to 90 mL of iopamidol (Iopamiro; Bracco Imaging Italia srl, Milan, Italy) was injected at a rate of 5 to 5.5 mL/s through the antecubital vein. The arrival of the contrast was monitored by acquisition of axial images at the level of the abdominal aorta 10 seconds after infusion of contrast. Acquisition of contrast began automatically when the threshold of 200 Hounsfield units was achieved in the region of interest (abdominal aorta). The detector covering width was 40 mm and the scanning slice thickness was 5 mm. For image reconstruction, a retrospective analysis of the electrocardiographic tracing was employed, searching for the best image during the middle of diastole. The entire block was reprocessed with a thickness of 0.625 mm and was analyzed at a workstation (Advantage Workstation 4.6; GE Healthcare). CTA scanning ranged from the level of the renal artery to the knee joint (Figure 1).

### DLCFA Harvesting Technique

Through an anterior-lateral skin incision of about 15 to 18 cm at one-third of the upper and mid-part of the thigh, the DLCFA was well exposed and dissected (Video 1). Incisions were made along the axis connecting the femoral artery pulsatile point at the level of groin with the

**FIGURE 1.** Reconstructed image of the DLCFA. The DLCFA can been see clearly on the reconstructed CTA image (*arrow*).



**VIDEO 1.** Harvesting and application of the DLCFA, *DLCFA*, Descending branch of the lateral circumflex femoral artery. Video available at: https://www.jtcvs.org/article/S0022-5223(19)32277-9/fulltext.

superior edge of the patella, with the starting point of the incision at 5 to 6 cm below the pulsatile point (Figure 2). After the deep fascia (fascia lata of the quadriceps) was incised, the rectus femoris was exposed. Using a blunt dissection technique, the rectus femoris muscle was separated clearly from the vastus lateralis muscle. Retracting the rectus femoris to the internal side, the DLCFA could be seen on the surface of the vastus intermedius muscle (Figure 3).

The DLCFA runs downward through the intermuscular space accompanied by the muscular branch of the femoral nerve, ending in the vastus intermedius muscle near the knee joint. There are several musculocutaneous perforators arising from the descending branch that should be ligated. We removed the descending branch together with the accompanying veins (usually 2) that share the same tunica adventitia. The proximal side would be dissected as near as possible to its origination point. The distal end was tracked and ligated either before the DLCFA enters the vastus intermedius muscle or before it splits into the minor muscular branches, to maintain the caliber of the distal end at least 2 mm. Once the DLCFA was obtained, it should be preserved in calcium channel blocker solution (10 mg of diltiazem in 200 mL of physiological saline) before use.

### Technique for DLCFA Graft Establishment

All DLFCA grafts were anastomosed onto a previously selected coronary artery with an acceptable lumen diameter and atherosclerotic obstruction of 70% or more. If the target vessel was the first diagonal branch or the ramus intermedius branch, the DLCFA could be used as a free graft with the proximal anastomosis directly on the ascending aorta. It also could be used as a composite graft with the left internal thoracic artery (LITA) or with free graft of RA/SVG in end-to-side anastomosis as a "Y" shape, with the distal anastomosis on the second or the third obtuse marginal branch of circumflex or more distant diagonal branch. The anastomoses were performed using a continuous 7-0 polypropylene suture. Usually, the proximal anastomosis of the composite grafts was constructed at the end of the operation while the patients were on cardiopulmonary bypass in on-pump CABG, so as to adapt to the position of distal anastomosis. In 1 patient, a "Y"-shape composite conduit of DLCFA with in situ right internal thoracic artery (RITA) was prepared before initiating extracorporeal circulation, and then was anastomosed with the posterior descending branch. The distal end of that RITA was anastomosed with the right coronary artery as planned.

**FIGURE 2.** Incision made for DLCFA harvesting. A 15- to 18-cm length incision was made along the axis connecting the femoral artery pulsatile point at the level of groin with the superior edge of the patella, with the starting point of the incision at 5 to 6 cm below the pulsatile point.

## RESULTS

Of the 44 patients in the planned selection group, DLCFA was abandoned in 8 male patients because of the unsatisfactory results of CTA screening. The exclusion rate was 18.2%. The main reasons for abandonment were anatomical variation, very short length, and/or narrow lumen diameter (Table 1).

In the remaining 36 cases confirmed by CTA, DLCFA were successfully harvested and used during the operation. In 20 of these, CTA indicated that the bilateral DLCFAs were not equal and there was dominant side (15 patients on the right side and 5 patients on the left side). Therefore, the DLCFA on the dominant side was harvested. CTA of the other 16 patients showed that the bilateral DLCFAs were equivalent. Then, the left-sided DLCFA was harvested. Finally, in the planned selection group, DLCFA was harvested from the left thigh in 21 patients and from the right thigh in 15 patients.

Of the 5 patients in the temporary decision group, DLCFA on the left side was harvested. However, 1 was abandoned because of short length (6 cm) and thin caliber (less than 1.5 mm). The exclusion rate was 20%.

A total of 40 patients underwent CABG using the DLCFA as the conduit. The CABG operations were performed under cardiopulmonary bypass support (30 cases) or under beating-heart conditions (10 cases). There was

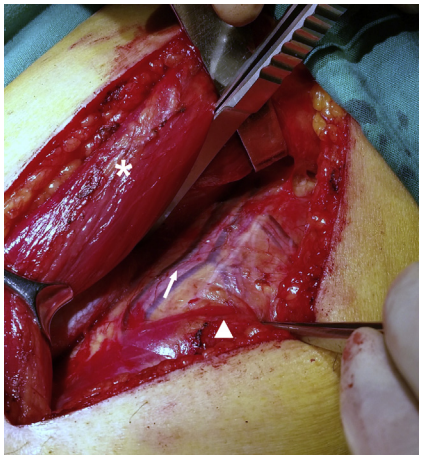


**FIGURE 3.** Anatomic position of the DLCFA. After a blunt dissection to separate the rectus femoris muscle (*asterisk*) from the vastus lateralis muscle (*arrowhead*), and retracting the rectus femoris to the internal side, the DLCFA (*arrow*) could be seen on the surface of the vastus intermedius muscle. *DLCFA*, Descending branch of the lateral circumflex femoral artery.

total arterial CABG in 75%, and multiple arterial CABG (including at least 3 arterial conduits) in the remaining 25%. On average, 3.7 ± 0.9 distal anastomoses were constructed in these 40 patients. The conduits other than the DLCFA included in situ LITA in 40, in situ RITA in 8, free RITA in 8, RA in 32, and SVG in 10.

The length of the harvested DLFCA was 9.9 ± 1.7 cm, with average proximal lumen diameter of 3.4 ± 0.7 mm. DLFCA was used as free graft in 26 patients and as "Y"-shape composite graft in 14 patients (Table 2).

**TABLE 1. Reasons for abandonment after CTA screening**

| No. | Age, y | Reason for DLCFA abandonment |
|---|---|---|
| 1 | 49 | Severe stenosis of bilateral common iliac artery |
| 2 | 48 | Went deeply into the vastus lateralis muscle very early |
| 3 | 50 | Short length on both sides (CTA evaluation length were 8 cm) |
| 4 | 56 | Couldn't be found on right side; very short length on left side |
| 5 | 47 | Short length (CTA evaluation length was 6 cm) and small diameter (CTA evaluation proximal diameter was 2 mm) |
| 6 | 47 | Not in the normal position, passage under the deep muscle |
| 7 | 32 | Moderate and severe stenosis of superficial femoral artery |
| 8 | 54 | Multiple occlusions of the lower extremity artery with severe stenosis of the proximal end of the DLCFA |

*DLCFA*, Descending branch of the lateral circumflex femoral artery; *CTA*, computed tomographic angiography.

All patients recovered and were discharged uneventfully. No clinical complications related to the DLFCA graft were observed during the hospital stay. No ischemic events, re-explorations for bleeding, sternal infections, or mediastinitis was observed in any patient. There were no functional deficits of lower limbs or compartment syndrome arising from dissection of the DLFCA. The wound for DLCFA harvesting healed well and rapidly. During follow-up, there were no postoperative complications, including vascular supply or innervation disorders, infection, edema, or major hematoma.

## DISCUSSION

Despite the fact that the LITA and RA are routinely used in CABG, cardiac surgeons still search for new arterial grafts to avoid remote cardiac events associated with graft failure and to improve the quality and expectancy of life in patients with coronary artery disease.

Inspired by orthopedic surgery, in which the DLCFA has been used in anterolateral thigh flaps since the 1980s to supply composite skin and muscle tissues,[6] the DLCFA has attractive characteristics that qualify it as an option for arterial grafting in surgical myocardial revascularization. The first case in which the DLCFA was used as a graft in CABG was performed in Japan and was reported by Tatsumi in 1996.[3]

Sakakibara and colleagues[7] reported that wall irregularities of the DLCFA were noted in 35.8% in 120 limbs and suggested that there would be a high incidence of atherosclerotic changes in DLCFA. In their study, only 10% DLCFA would be useful as conduits in CABG. The possible high incidence of atherosclerosis was once one of the concerns that hindered the use of this conduit.

The study of Halvorson and colleagues[8] indicated that the DLCFA showed no atherosclerotic changes in 87%, mild changes in 4.5%, moderate changes in 1.5%, and severe changes in 7% of the cases. Furthermore, they found that diabetes, hypertension, and smoking did not have a significant correlation with the degree of stenosis of DLCFA; especially in patients with peripheral occlusive arterial disease, the DLCFA retained its patency thanks to local hemodynamic factors (sheer stress, flow pattern) of the deep femoral artery, rendering the descending branch resistant to atherosclerosis. This finding was also supported by Lee and colleagues.[9] In our cohort, atherosclerotic changes of DLCFA were found only in 3 patients, limited to the proximal part of the vessel that did not interfere with its use. One of the patients was eliminated by preoperative CTA screening due to multiple occlusions of the lower-extremity artery with severe stenosis of the proximal end of the DLCFA. According to the hypothesis of Halvorson and colleagues, DLCFA may also be available for use in this patient.

The clinical application of DLCFA in CABG has been plagued by 2 problems. One is that DLFCA can present anatomical variations, including medial position, hypoplasty, and failure of identification, which make the artery difficult to be dissected or to be used.

**TABLE 2. Types of DLCFA grafts**

| Type | Proximal site | Distal site | Number |
|---|---|---|---|
| Free graft | Ascending aorta | First diagonal branch | 18 |
| | | Ramus intermedius branch | 5 |
| | | Second obtuse marginal branch | 2 |
| | | Left anterior descending branch | 1 |
| "Y"-shape composite graft | In situ LITA | Second obtuse marginal branch | 4 |
| | | Third obtuse marginal branch | 5 |
| | In situ RITA | Posterior descending branch | 1 |
| | Free graft of RA | Second diagonal branch | 2 |
| | Free graft of SVG | Third obtuse marginal branch | 2 |

*LITA*, Left internal thoracic artery; *RITA*, right internal thoracic artery; *RA*, radial artery; *SVG*, great saphenous vein.

The variations of the descending branch may be related to the origin variations of the lateral circumflex femoral artery (LCFA). Fukuda and colleagues[10] reported that there were 6 patterns of anatomical variation for LCFA origin. Except for the pattern with the LFCA arising from the deep femoral artery, other LFCA variants are prone to developing an immature descending branch.

In a study from Brazil,[5] in 6 of 32 selected patients, the DLCFA was inappropriate for use as a graft because 4 presented very short length and/or narrow lumen diameter, 1 had severe atherosclerosis, and 1 was not found. These 6 cases were excluded from the study in the operating room with a 19% exclusion rate. Of the 5 patients in our group in whom it was temporarily determined to use DLCFA during the operation, one was abandoned because of short length and thin caliber. Yamashita and colleagues[11] strongly advised that preoperative angiogram be performed when DLCFA was planned for CABG.

We used CTA as a regular preoperative screening method in this study and achieved satisfactory results. In this way, the DLCFA with anatomical variation or atherosclerotic change could be discovered before the operation. Following the procedure shown in Figure 4, of the 44 patients, 36 DLCFAs proved to be available according to CTA examination and all were successfully used. Because the DLCFA does not always develop symmetrically in both thighs, CTA also assist selection of the dominant side to choose the better graft.

In most cases, the DLCFA can be safely harvested. Only 4% patients may experience transient dysesthesia of the thigh. Plastic surgeons from the Netherlands, Hage and Woerdeman[12] reported a patient with partial necrosis of the foot and calf caused by interruption of the DLCFA, which acted as a critical collateral for an obstructed superficial femoral artery. CTA can provide accurate information regarding these types of contraindication for use of the DLCFA. We eliminated 1 patient because CTA revealed an occlusive lesion in superficial femoral artery. CTA was an ideal noninvasive method for preoperative assessment of DLCFA and should be used in all scheduled patients.

Another problem affecting clinical use was that the length of the segment of the DLCFA with caliber suitable for bypass graft may be too short. The length of the


**FIGURE 4.** The DLCFA has a certain rate of abandonment because of the presence of an anatomical variation and short length for use. This arterial conduit, when it is proved to be available according to preoperative multidetector computed tomographic angiography screening, can be harvested conveniently at its normal anatomical site through an anterior-lateral skin incision on the thigh and can be successfully used in the coronary artery bypass operation. *CTA*, Computed tomographic angiography; *DLCFA*, descending branch of the lateral circumflex femoral artery.

available segment was not proportional to the length of the thigh. Some may have very strong descending branches at the origin, and also have well developed musculocutaneous perforator branches. After these branches arise, the main stem rapidly becomes substantially smaller.

In our study, the diameter of the distal end in the harvested segment of the DLCFA needs to be at least 2 mm. According to this standard, the average length of the harvested DLCFA graft was 9.9 cm, similar to the result reported by Loskot and colleagues (9.3 ± 2.9 cm).[4] However, the DLCFA segment in this average length could not be always used as a free graft. Appropriate graft establish strategy should be considered during CABG.

Fabbrocini and colleagues[13] regularly used the DLFCA as a composite graft with the LITA in their patients. In the report of Schamún and colleagues,[14] the DLFCA was not only used as a composite graft with the LITA (end-to-side with a Y shape) but also as an extension of the right internal thoracic artery (end-to-end anastomosis to revascularize the distal portion of the right coronary artery) or as a free aorta-coronary graft. In this group, if the target vessel was the first diagonal branch, the ramus intermediate branch, or the first obtuse marginal branch, the DLCFA was considered as a free graft. Otherwise, composite graft strategy was chosen.

There was seldom report on the long-term result about this conduit. A study from Italy[13] reported 1-year patency was 97%, whereas the 3-year patency was 93%. In the report of Gaiotto and colleagues,[5] the patency rates of the DLCFA grafts were 96% on the 7th day and 92% on the 90th day after surgery. Among our patients who had completed the 1-year follow-up, coronary CTA indicated that the patency rate of DLCFA was similar to that of RA, lower than that of LITA, but better than that of RITA used as a free graft. Limited to the fewer cases and shorter follow-up time, the patency rate of the DLCFA graft needs further study and observation.

### Limitations

In this study, more attention was paid to increasing the use of DLCFA, an arterial conduit, in CABG operation through technical improvements. In fact, the patency rate of this conduit is another important point that need to be focused. However, the present study does not yet provide detailed and comprehensive data on this subject.

Only 22 patients in the group had completed the 1-year follow-up by CTA examination. The follow-up data showed the 1-year patency rates for different arterial conduits were LIMA 95.4% (21/22); RA 88.9% (16/18); DLCFA 86.4% (19/22); in-site RIMA 87.5% (7/8); and free RIMA 75% (3/4). Limited to the number of cases, this result may not be accurately representative. More case data and longer follow-up will also be required to reach more meaningful conclusions. This should be the key point of the next step.

## CONCLUSIONS

To perform total or multiple arterial revascularization CABG, more alternative arterial conduits are needed. The DLCFA is an option. However, preoperative CTA examination is necessary before this artery is used in CABG, and an appropriate strategy for graft establishment should be considered.

### Conflict of Interest Statement

Authors have nothing to disclose with regard to commercial support.

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**Key Words:** coronary artery bypass grafting, descending branch of the lateral circumflex femoral artery, computed tomographic angiography