Feasibility and Safety of Concomitant Left Internal Mammary Arteriography at the Setting of the Right Transradial Coronary Angiography

Kwang Soo Cha,* MD, and Moo Hyun Kim, MD

We investigated the feasibility and safety of concomitant left internal mammary artery (LIMA) angiography at the setting of the right transradial coronary angiography (TRCA). LIMA angiography was performed using a 5 Fr Simmons-type catheter with a newly modified tip in 184 consecutive patients. The catheter was reformed in the descending (new method) or ascending (traditional method) aorta and manipulated to cannulate the left subclavian artery and LIMA orifice. LIMA angiography was performed selectively in 164 patients (89%) and semiselectively (when the catheter tip reached and was directed to the mammary artery orifice) in 20 patients. There were no procedure-related complications. The image quality of all the semiselective angiograms was also determined satisfactory. Total procedural time was 223 ± 168 sec. The catheter was reformed using the new method in 160 patients (87%). The catheter reformation time and total procedure time were significantly shorter with the new method than with the traditional method (18 ± 8 vs. 117 ± 115 sec, p = 0.000; 204 ± 191 vs. 309 ± 139 sec, p = 0.021, respectively). In conclusion, LIMA angiography can be performed readily and safely at the setting of the right TRCA using a Simmons-type catheter. The image quality of the LIMA angiograms is sufficient to obviate the need of the second preoperative angiography via another route. Cathet Cardiovasc Intervent 2002;56:188–195. © 2002 Wiley-Liss, Inc.

Key words: mammary artery; angiography; radial artery

INTRODUCTION

Internal mammary arteries have been extensively employed as bypass grafts due to a far superior long-term patency rate compared to venous grafts [1]. Therefore, preoperative evaluation of the mammary arteries should be done to ensure their patency prior to use as bypass grafts [2], when a patient is judged to be a candidate for bypass surgery after diagnostic coronary angiography. Transfemoral route has remained the choice approach for internal mammary arteriography [3]. Before the current era of transradial artery catheterization, ipsilateral transbrachial technique was used to perform mammary arteriography, although techniques that used the contralateral brachial artery to perform the mammary arteriography were described [4,5]. Since the introduction of the radial artery as an access route for performing coronary angiography in 1989 by Campeau [6], the transradial approach has gained a wide acceptance in performing coronary angiography and interventional procedures [7–11].

To perform the left internal mammary artery (LIMA) angiography concomitantly at the time of the right transradial coronary angiography (TRCA), few techniques using special catheters, either mammary shape [12] or left Judkins 1.0 catheter [13], have been described. However, these techniques may be difficult to perform and time-consuming. A reliable and safe angiographic technique of the LIMA has not established at the setting of the right TRCA. Therefore, when a patient is judged to be a candidate for bypass surgery after diagnostic coronary angiography performed via the right radial route, the second preoperative LIMA angiography may be needed via the left brachial, radial, or femoral route. In the present study, we investigated the feasibility and safety of concomitant LIMA angiography at the setting of the right TRCA in nonselected patients.
MATERIALS AND METHODS
Study Population

From March 2000 to December 2000, LIMA angiography was performed immediately after diagnostic coronary angiography via the right radial approach in 184 consecutive patients. There were 125 men (68%) and mean age was 61 ± 6 years (range, 37–82 years). Mean height was 1.64 ± 0.07 m (range, 1.45–1.80 m) and mean body weight 64.64 ± 6.95 kg (range, 40.00–90.00) and mean body mass index 24.09 ± 2.12 kg/m² (range, 17.09–30.48 kg/m²). Coronary angiography was performed in 50 patients (27%) with effort angina, 11 patients (6%) with recent myocardial infarction, and in 94 patients (51%) for the follow-up evaluation of previous percutaneous intervention or bypass surgery. Twenty-nine patients (16%) were examined for the evaluation of atypical chest discomfort. The angiography demonstrated coronary artery disease in 155 patients (84%). The patients, in whom coronary angiography was difficult due to severely tortuous right subclavian artery, were excluded from performing LIMA angiography concomitantly. This study was approved by the ethics committee of the institute and written informed consent was obtained from every patient.

LIMA Angiography Using a Simmons-Type Catheter With a Newly Modified Tip

All patients were encouraged to continue medications such as aspirin (100–200 mg/day), calcium channel antagonists, and nitrates. After arterial puncture, the right radial access was established with insertion of a 5 Fr sheath (Maximum hemostasis introducer set, DAIG). Saline solution containing nitroglycerin (200 μg), verapamil (2 mg), and heparin (5,000 U) was administered through the arterial sheath sidearm. Selective coronary angiography was performed in the usual manner using 5 Fr multipurpose Judkins or Amplatz catheters (USCI). In patients with previous bypass surgery, venous graft angiography was performed using Amplatz right or left catheters (USCI) after native coronary angiography.

LIMA angiography was performed using a 5 Fr Simmons-type catheter with a newly modified tip (manufactured by Jung Sung, Korea; Fig. 1.). The tip is 0.5 cm in length, bent 80° laterally and twisted 80° anteriorly in order to cannulate easily the LIMA orifice, which is located at the anterior surface of the left subclavian artery rather than the inferior surface of it. The distal portion of the catheter curve is also bent in order to be more easily accommodated in the left subclavian artery. Catheters
with three different curve lengths (7.5, 7.7, and 8.5 cm) were used to reach the LIMA orifice (Fig. 2.). The catheter with curve length of 7.7 cm was first introduced into the descending aorta over a 0.035\(^{\circ}\) 263 cm flexible guidewire (Radifocus Guide Wire M, Terumo, Japan), and the catheter was reformed with its tip pointing upwards (new method; Fig. 3.) Alternatively, in the presence of a tortuous right subclavian artery or elongated and more vertically oriented ascending aorta, the catheter was placed in the ascending aorta over a stiff guidewire (Amplatz Super Stiff, 0.035\(^{\circ}\) 260 cm; Boston Scientific) to reform a similar loop using a technique previously described (traditional method; Fig. 4) [4,5,14]. Without the guidewire, the reformed catheter was slowly withdrawn and its tip was directed toward the left part of aortic arch (Fig. 5A). Clockwise rotation of the catheter permitted its advancement into the left subclavian artery. After the catheter position and LIMA orifice were confirmed by test injection of contrast agent (Fig. 5B), the catheter was withdrawn to reach the orifice and, if necessary, rotated clockwise in order to direct the tip anteriorly and cannulate the orifice (Fig. 5C). Once the orifice was cannulated or, in the case of difficult cannulation, optimal alignment of the catheter tip with the orifice was achieved (semiselective cannulation), angiography was performed in antero-posterior projection and additional projection by hand injection with 6–8 ml of contrast agent (Fig. 5D). In patients with a tortuous right subclavian artery, a stiff guidewire was placed within the catheter to straighten the tortuous artery and to provide better torque control for the selective cannulation of the LIMA. After obtaining the LIMA arteriograms, the catheter was removed safely after being advanced slightly to come out from the orifice and the flexible guidewire (Radifocus Guide Wire M) being replaced within the catheter beyond its tip.

In case of semiselective cannulation of the LIMA orifice, the image quality of the angiograms was assessed using the criteria of Bhatt et al. [15] by the angiographic operator and a cardiovascular surgeon. The image was determined to be satisfactory when in the native LIMA, its proximal and distal segments were fully visualized, and in the grafted LIMA, the entire length of the vessel including the anastomosis site and distal runoff vessels were fully visualized in two orthogonal views. Disagreements, if any, were resolved by consensus.

RESULTS

Out of the 184 patients, the right subclavian and innominate artery was moderately tortuous in 50 patients (27\%), and the ascending aorta was elongated and more vertically oriented in 50 patients (27\%). Six patients (3\%) were excluded from the concomitant LIMA angiog-
raphy because of severely tortuous right subclavian artery.

The LIMA angiography was performed selectively in 164 patients (89%) and semiselectively (when the catheter tip reached and was directed to the mammary artery orifice) in 20 patients (due to the tortuosity of the right subclavian artery or suboptimal alignment of the catheter tip with the mammary artery orifice). There were no procedure-related complications, including major cerebrovascular events, arterial dissection, or thromboembolism. The image quality of all the semiselective native and grafted (Fig. 6). LIMA angiograms was also determined satisfactory.

The catheter was reformed successfully in the descending aorta with the new method in 160 patients (87%) but in other 24 patients, in whom the new method was impossible due to vertically elongated aortic arch, it was reformed in the ascending aorta with the traditional method. The mean time from the catheter insertion in the radial artery to reformation of the catheter in the aorta (catheter reformation time) was 47 ± 76 sec (range, 10–550 sec). The mean time to further cannulate (can-nulation time) the left subclavian artery and the mammary artery orifice with the catheter was 48 ± 76 sec (range, 2–420 sec) and 69 ± 87 sec (range, 25–575 sec), respectively. The mean total procedural time from entry

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**Fig. 3.** Reformation of a Simmons-type catheter in the descending aorta. A: A flexible Terumo guidewire (arrow) is introduced into the descending aorta. B: A Simmons-type catheter is advanced into the proximal portion (arrowhead) of the descending aorta over the guidewire. C: The catheter is reformed by slight advancement during inspiration. D: The catheter is slided into ascending aorta by further advancement.
of the catheter into the radial artery to the completion of the LIMA angiography was 223 ± 168 sec (range, 48–905 sec). The catheter reformation time and the total procedure time of the LIMA angiography were significantly shorter with the use of the new method of catheter reformation than with the traditional method of it (18 ± 8 vs. 117 ± 115 sec, p = 0.000; 204 ± 191 vs. 309 ± 139 sec, p = 0.021, respectively; Table I).

DISCUSSION

This study demonstrated that LIMA angiography can be performed readily and safely at the time of the right TRCA using a 5 Fr Simmons-type catheter with a newly modified tip. Selective cannulation of the LIMA orifice was achieved in 164 patients (89%). Even in the other 20 patients in whom the orifice was cannulated semiselectively, the image quality of the LIMA angiograms was determined sufficient to evaluate the mammary artery. The mean total procedural time was 223 ± 168 sec (range, 48–905 sec) and we completed the LIMA angiography in an average time of less than 4 min in 90% of the patients.

Before the current era of transradial artery catheterization, Singh [4] first described a technique for selective LIMA angiography via the right brachial approach with

Fig. 4. Alternative reformation of a Simmons-type catheter in the ascending aorta in a patient with a tortuous right subclavian artery or an elongated and more vertically oriented aortic arch. A: A Simmons-type catheter is advanced to the ascending aorta over a stiffer guidewire. While the guidewire tip is concealed in the catheter, the catheter tip is in contact with an aortic cusp (arrowhead). B: The distal portion of the catheter is folded into a loop by careful advancement. C: With the loop being preserved, the catheter is withdrawn to the aortic arch to direct its tip toward innominate artery. A Terumo flexible guidewire (arrow) is used to replace the catheter. D: With the guidewire in place (arrow), the reformed catheter is manipulated in the ascending aorta to make the catheter tip direct upwards.
a specially designed 8 Fr catheter in 75 patients. Selective cannulation of the LIMA was successfully performed in 59 patients (78%) and impossible in 12 patients (16%) due to the anterior location of the orifice. However, the proximity of the orifice allowed it to be reached and semiselective injection of contrast agent to be performed. Similarly, Dorros and Lewin [5], after the technique of Singh [4] or Londero and de la Fuente [14], maneuvered and placed a 8 Fr Simmons catheter, preloaded with a guidewire, into the left subclavian artery beyond the mammary artery. The catheter was replaced with a 7 Fr mammary bypass catheter with the aid of an exchange wire, and then the LIMA was cannulated.

There were two preliminary reports of selective LIMA angiography via the right radial approach [12,13]. Using 4 Fr mammary shape catheters, Louvard [12] was successful in performing selective LIMA angiography in 10 of 13 patients (77%) with relatively prolonged mean procedural time of 32 ± 14 min. With 4 Fr JL-1.0 (Baby Judkins) catheters, Yabe et al. [13] were able to cannulate the LIMA in 76 of 80 patients (95%), while procedure time was not reported. Selective engagement of the artery was not possible in patients with the ascending aorta larger than 37 mm in diameter combined with mild to moderate aortic regurgitation.

In the present study, we utilized a Simmons-type catheter because its typical shape could be more suitable to
cannulate the left subclavian artery and to reach the LIMA. The catheter is basically similar to the catheter of Singh [4], but our shape has peculiar difference to enhance the cannulation of the LIMA orifice. The tip of the catheter is bent and directed anteriorly rather than inferiorly because the LIMA orifice is in fact located at the anterior surface of the left subclavian artery rather than the inferior surface of it. The anterior location of the orifice was the main cause of failure of selective cannulation [4]. The reformation of Simmons catheter into its preformed shape in the aorta may be a challenge when the catheter is used via the right arm. In patients with moderate tortuosity of the right subclavian and innominate artery or with a more vertically oriented aortic arch, we used the technique of Singh [4], Dorros and Lewin [5], or Londero and de la Fuente [14] to reform the catheter in the ascending aorta (Fig. 4). However, in ordinary cases, which comprised 87% of our consecutive 184 patients, it was easier to reform the catheter in the descending aorta (Fig. 3).

Performing selective LIMA angiography concomitantly at the setting of the right TRCA may have limitations. First, the tortuosity of the right subclavian and innominate artery may limit the torque of a small-caliber catheter. In addition, an elongated and more vertically oriented ascending aorta may not allow the catheter to advance into the left subclavian artery. Second, once the catheter is placed within the left subclavian artery, it may be difficult to reach the LIMA orifice and at times coaxial alignment of the catheter tip with the orifice may not be obtained. Third, LIMA angiography via the right arm may increase the potential risk of embolization when the catheter is reformed in the ascending aorta or manipulated aggressively in patients with a severely tortuous subclavian and innominate artery. Left subclavian artery stenosis may also increase the embolic risk while manip-

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<th>New method (n = 160)</th>
<th>Traditional method (n = 24)</th>
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<tr>
<td>Catheter reformation time (sec)</td>
<td>18 ± 8</td>
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<td>Left subclavian cannulation time (sec)</td>
<td>43 ± 69</td>
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<td>LIMA cannulation time (sec)</td>
<td>65 ± 89</td>
<td>78 ± 81</td>
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<td>Total procedure time (sec)</td>
<td>204 ± 191</td>
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*Data presented are mean value ± SD.
*aUsing student’s t-test.

Fig. 6. The image quality of a semiselective grafted left mammary arteriography. A: The catheter tip is adjusted to achieve optimal alignment with the mammary artery orifice (semiselective cannulation, arrow) in the case of difficult cannulation. Angiography is performed by hand injection of 6–8 ml of contrast agent. B: The distal vessel (arrow) and collaterals (arrowhead) to other coronary territory are well defined.
ulating to cannulate left subclavian or mammary artery ostium. The test injection of contrast agent in the aortic arch is helpful to evaluate the status of the subclavian artery.

In conclusion, this right transradial technique obviates the need of the second preoperative LIMA angiography via another route when a patient is judged to be a candidate for bypass surgery after diagnostic coronary angiography performed via the right radial approach. In addition, it may provide a safe and useful alternative for performing LIMA angiography in situations where a choice transfemoral, left transbrachial, or transradial approach is difficult or impossible.

REFERENCES