

Academic article

Two case reports of coronary artery bypass grafting in adults with dextrocardia with situs inversus

Suksan Kanoksin,^{1*} Wiroon Napa-umporn,² Teerawit Phanchaipetch³

¹*Cardiovascular and Thoracic Surgery Unit, Heart Center, Chulabhorn Hospital, Chulabhorn Royal Academy, Thailand*
Paramedicine Program, Faculty of Health Science Technology, HRH Princess Chulabhorn College of Medical Science, Chulabhorn Royal Academy, Thailand

²*Andaman Heart Center, Vajiraphuket Hospital, Thailand*
³*Cardiovascular and Thoracic Surgery Unit, Department of Surgery, Siriraj Hospital, Mahidol University, Thailand*

*Corresponding author, e-mail : ksuksan@yahoo.com

Received: 6 September 2022; Revised: 4 March 2024; Accepted: 25 March 2024

Abstract

In patients with dextrocardia, the cardiac apex points to the right side of the chest wall, and situs inversus is when the internal abdominal organs are positioned on the same side as the cardiac apex. Congenital dextrocardia with situs inversus has been rarely reported, and some patients with dextrocardia also develop atherosclerotic coronary artery disease. We report two cases of on-pump coronary artery bypass grafting performed in patients with dextrocardia with concomitant atherosclerotic coronary artery disease.

The first case was a 56-year-old Thai male who was in a car accident while he experienced a transient ischemic attack (TIA). He was admitted for treatment and underwent an investigation to identify the cause of the TIA. Cardiac echocardiography showed abnormal myocardial contraction. Coronary angiography showed critical three-vessel coronary artery disease. Elective on-pump coronary artery bypass grafting was successfully performed. The second case was a 68-year-old female who presented with non-ST-elevation myocardial infarction. Coronary angiography showed coronary artery disease with a left main lesion. Cardiac echocardiography showed a left ventricular ejection fraction of 33%. Three-vessel coronary artery bypass grafting was performed. The patient experienced good postoperative recovery without any complications.

We conclude that coronary artery bypass grafting in patients with dextrocardia can be successfully performed using the on-pump coronary bypass surgery technique, and the right internal mammary artery is an appropriate arterial conduit for the left anterior descending artery.

Keywords : coronary artery bypass grafting, dextrocardia, pleural effusion, situs inversus, surgeon standing position

Introduction

Dextrocardia with situs inversus, a congenital abnormality that is linked to mutated genes causing an autosomal recessive disorder,¹ is more common than levocardia with situs inversus. Pediatric patients with this condition usually grow into adulthood without abnormal symptoms. The incidence is approximately 1 in 10,000 for dextrocardia with situs inversus totalis² and 1 in 31,000–37,000 for isolated dextrocardia.³ Despite surviving to adulthood, individuals may experience ischemic heart disease requiring intervention.⁴ The first coronary artery bypass surgery for dextrocardia was reported in 1980.⁵

It is difficult to measure whether the incidence of coronary artery disease (CAD) among those with dextrocardia with situs inversus is equal or different from the general population as the number of patients with dextrocardia is too small to compare the incidence. Patients with adult congenital heart disease who have undergone surgery at a young age to fix the defects live longer but engage in fewer daily activities. As a result, they have a greater chance of developing CAD.⁶ For example, those who undergo surgery to fix aortic coarctation would be at a significantly higher risk of getting CAD.

The common challenge for individuals with the abovementioned two diseases is an abnormal anatomy that makes it difficult for them to undergo surgery. Surgeons should thoroughly plan the surgical procedure and their preferred standing positions before the operation is performed. As most surgeons tend to be right-handed, they may encounter difficulty when performing surgery in patients with dextrocardia.

Generally, on-pump and off-pump coronary artery bypass grafting (CABG) surgeries have similar survival rates, stroke risks, and myocardial infarction risks. Therefore, it is mostly up to the surgeon's preference to choose which CABG technique to use.⁷ However, for patients with dextrocardia who have an abnormal cardiac anatomy, surgeons may need to carefully and deliberately select surgical techniques to perform surgery with greater precision.

Given that only a small number of patients with dextrocardia live long enough to develop CAD and

undergo surgery to fix it, the comparative outcomes between patients who undergo conventional on-pump CABG and those who undergo off-pump CABG have not been evaluated. Here, we report two cases of on-pump CABG performed in patients with dextrocardia with situs inversus and concomitant CAD.

Content

Case I

A 56-year-old male presented to the hospital with a history of transient ischemic attack 12 hours before admission. He suddenly lost control of his car due to right-sided hemiparesis. His muscle strength fully recovered 12 hours after the incident. The carotid artery examination showed no significant lesions in either carotid artery, but echocardiography showed abnormal cardiac muscle wall motion and magnetic resonance imaging showed an ischemic myocardium. Coronary angiography was performed via the right femoral artery using the standard Judkins technique without modification other than mirror image reversal. The left anterior descending artery had 70% proximal luminal diameter narrowing. There was 90% obstruction in the circumflex artery and a 90% lesion in the midpart of the right coronary artery. The advantages and disadvantages of CABG were presented to the patient, who accepted the surgical risks.

Conventional elective on-pump CABG was performed. The right internal mammary artery was connected to the left anterior descending artery, while saphenous vein grafts were connected to the intermediate branch and distal circumflex artery in Y-graft fashion. A single saphenous vein graft was connected to the distal right coronary artery. The total bypass time was 90 minutes, while the aortic cross-clamp time was 60 minutes. The patient had good postoperative recovery. However, he had right pleural effusion, which responded well to a small daily dose (40 mg) of oral furosemide. At the 1-month follow up, chest X-ray showed a moderate amount of right pleural effusion. Percutaneous drainage was performed on the right chest wall, and around 1500 mL serosanguinous fluid was obtained. The patient had a good clinical appearance at the 3-month follow-up after surgery.

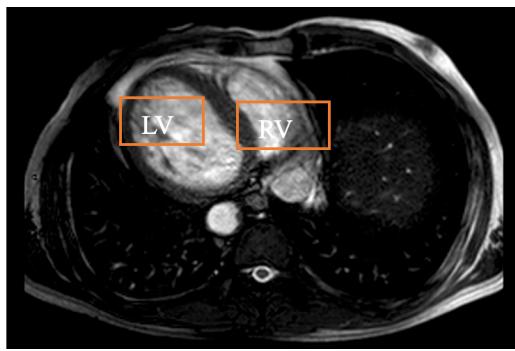


Figure 1. Magnetic resonance image showing dextrocardia.

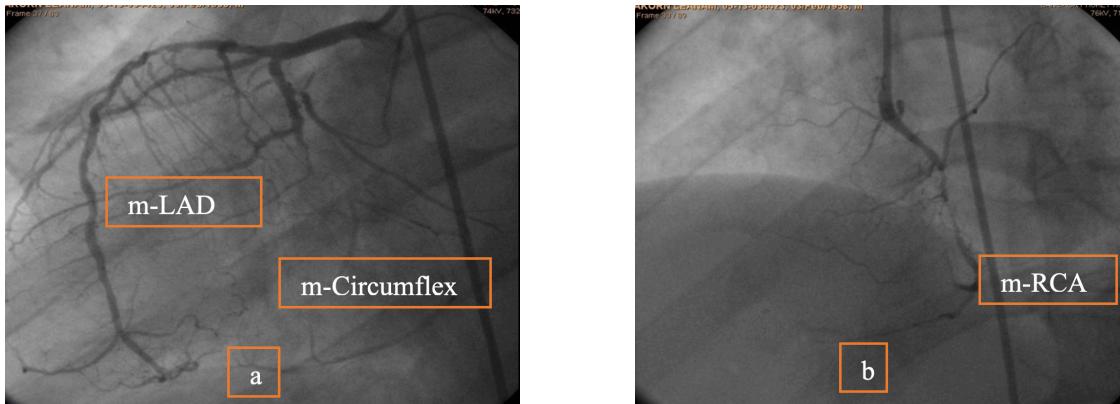


Figure 2. a. Coronary angiography image showing a significant stenotic lesion in the left anterior descending artery and circumflex arteries. b. Stenosis of the right coronary artery.

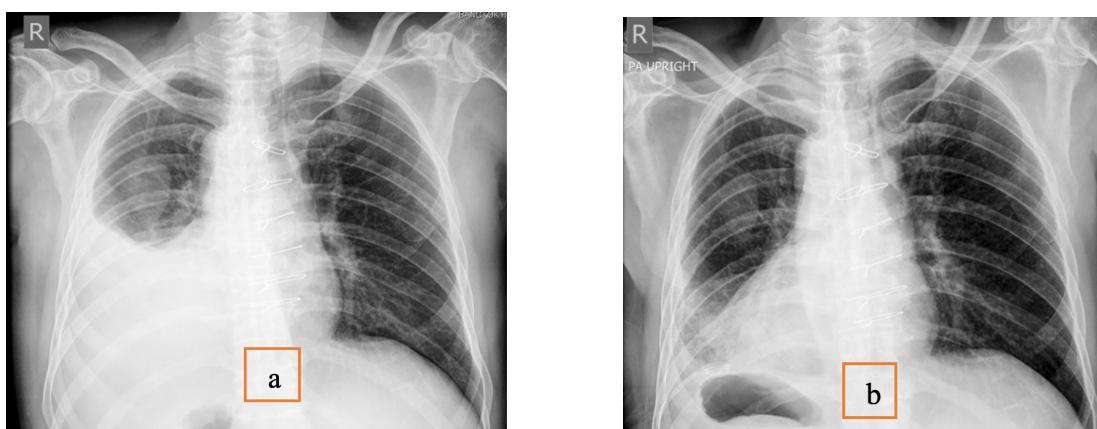


Figure 3. a. Chest X-ray image at the third postoperative week showing massive right pleural effusion. b. Chest X-ray image after percutaneous pleural fluid drainage.

Case II

A 68-year-old female with comorbid diabetes mellitus, hypertension, and dyslipidemia presented with chest pain in the epigastric area and radiating to both sides of the jaw. She had experienced intermittent pain for 1 week, which lasted for 1–2 minutes each time, before gradually disappearing. According to radiographic images displayed by the X-ray film, dextrocardia was identified, while the electrocardiogram showed poor R-progression in the chest leads (V1–V6) and ST-depression in lead V1. The level of troponin T was 179 ng/L. Echocardiography showed a left ventricular ejection fraction of 33%.

Coronary artery angiography was performed via the right femoral artery. The left coronary system was cannulated using a 6-Fr Judkins left 4 catheter. The right coronary artery was cannulated with a 6-Fr Judkins right 4 catheter using counterclockwise rotation. Significant lesions were identified in the left anterior descending artery, circumflex artery, and right coronary artery.

The patient underwent CABG to bypass three vessels using the right internal mammary artery to connect to the left anterior descending artery, and using the saphenous vein graft to connect to the circumflex artery and the right posterior descending artery. The total CABG procedure took around 90 minutes, while the aortic cross-clamp time was 51 minutes. After surgery, the patient recovered well, taking 1 week for postoperative care in the hospital before being discharged. One month after surgery at the postoperative follow-up visit, the patient's overall health was normal.

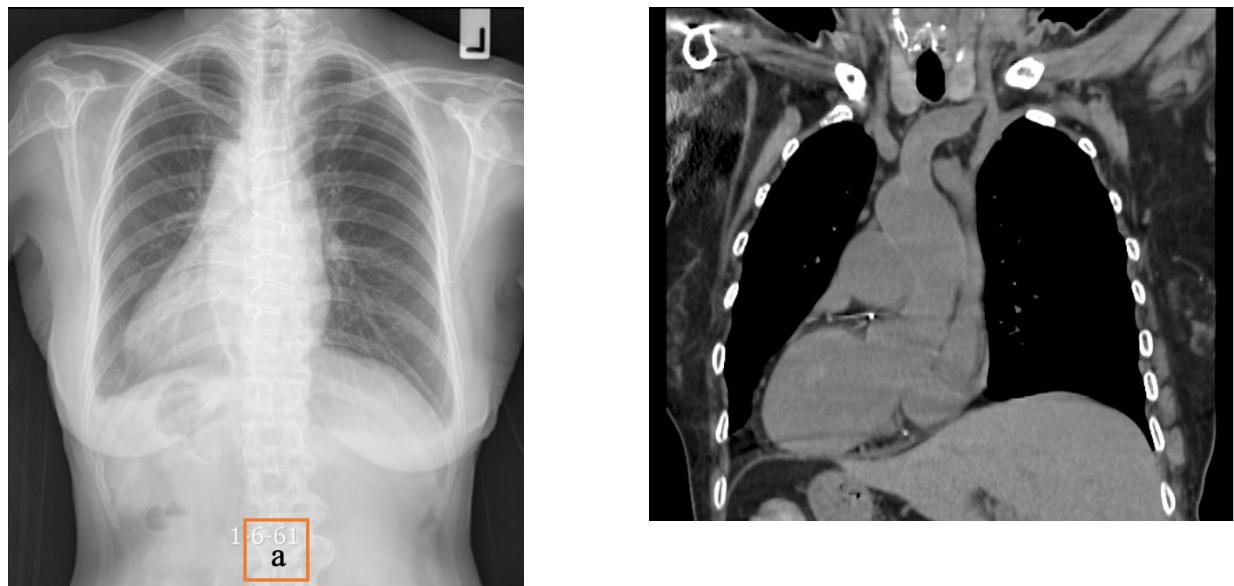


Figure 4. a. Chest X-ray image showing dextrocardia. b. Chest computed tomography image in the coronal plane showing dextrocardia.

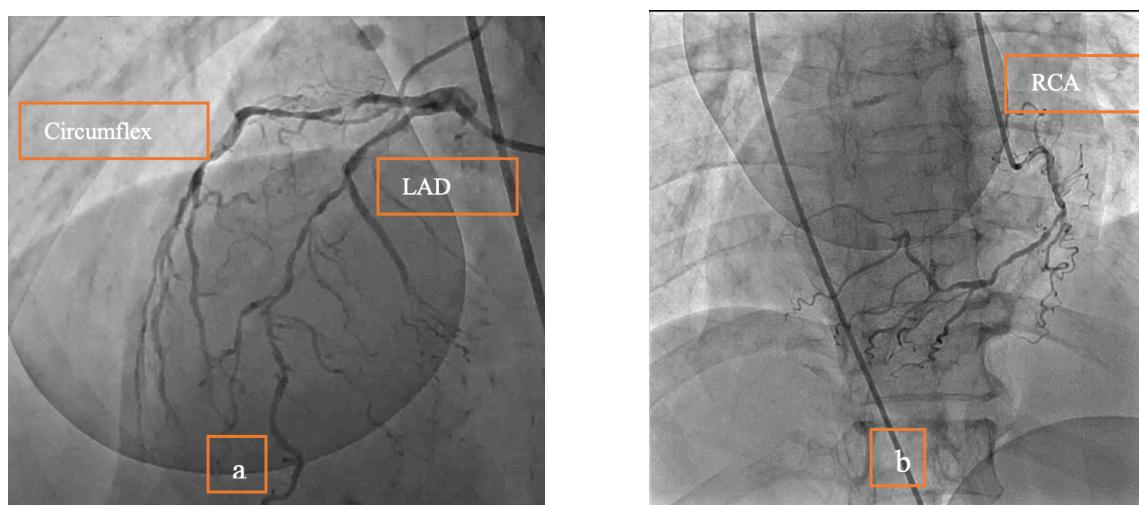


Figure 5. a. The image shows significant stenosis of the left anterior descending artery and circumflex artery. b. The image shows significant stenosis of the right coronary artery. LAD, left anterior descending; RCA, right coronary artery.

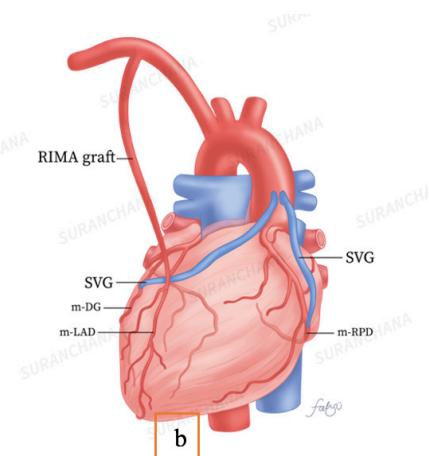
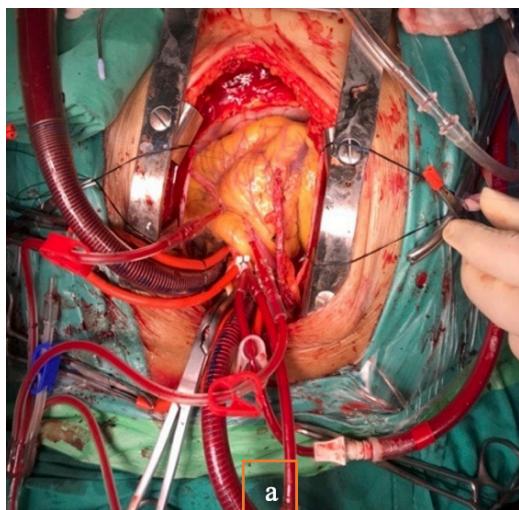


Figure 6. a. The image shows the operative field during coronary artery bypass grafting. b. Illustration of three-vessel coronary artery bypass grafting.

Table 1. Published case reports on CABG in patients with situs inversus.

No.	Author	Year	Journal	Country	Number of cases	Operation	On-/Off-pump	Conduits	Surgeon's position
1	Grey et al.	1981	Cardiovasc Dis	US	3	1 st case: CABG × 5 2 nd case: CABG × 2 3 rd case: CABG × 2	On-pump	SVG	Not mentioned
								SVG	Not mentioned
								SVG	Not mentioned
2	Irvin et al.	1982	Chest	US	1	CABG × 3	On-pump	SVG	Not mentioned
3	Moreno-Cabral, Daily PO.	1984	Chest	US	1	CABG × 3	On-pump	SVG	Not mentioned
4	Abensur et al.	1988	Chest	Brazil	1	CABG × 1	On-pump	RIMA	Not mentioned
5	Wong & Chong	1999	Med J Malaysia	Malaysia	1	CABG × 3	On-pump	RIMA, SVG	Left
6	Totaro et al.	2001	Ital Heart J	Italy	1	CABG × 3	On-pump	RIMA, SVG	Not mentioned
7	Tabry et al.	2001	Heart Surg Forum	US	1	CABG × 4	Off-pump	RIMA, LIMA (free), SVG	Left
8	Naik et al.	2002	Cardiovasc Surg (Torino)	Singapore	1	CABG × 2	On-pump	RIMA, SVG	Left
9	Erdil et al.	2002	Asian Cardiovasc Thorac Ann	Turkey	1	CABG × 2	On-pump	RIMA, SVG	Left
10	Stamou et al.	2003	J Card Surg	US	1	CABG × 2	Off-pump	RIMA, SVG	Both sides
11	Bonde & Cam-palani	2003	Interact Cardiovasc Thorac Surg	UK	1	CABG × 2	On-pump	RIMA, SVG	Left
12	Chui & Sarkar	2003	J Cardiovasc Surg (Torino)	UK	1	CABG × 2	On-pump	RIMA, LRA	Left
13	Bonanomi et al.	2004	J Cardiovasc Surg (Torino)	US	1	CABG × 2	Off-pump	RIMA, SVG	Not mentioned
14	Abdullah & Mazalan	2004	Heart Surg Forum	Malaysia	1	CABG × 3	Off-pump	SVG	Right
15	Kuwata et al.	2004	Jpn J Thorac Cardiovasc Surg	Japan	1	CABG × 5	Off-pump	RIMA, LIMA, RRA, LRA	Left
16	Cobiella et al.	2005	Rev Esp Cardiol	Spain	1	CABG × 2 + AVR + ascending aortic replacement	On-pump	RIMA, SVG	Right

17	Poncelet et al.	2006	J Cardiovasc Surg (Torino)	Belgium	1	CABG x 3	On-pump	RIMA, LIMA, GEA	Both sides
18	Ennker et al.	2006	Cardiovasc J S Afr	Germany	1	CABG x 2	Off-pump	RIMA	Left
19	Karimi et al.	2007	J Med	Iran	2	1 st case: CABG x 3	On-pump	RIMA, SVG	Right
						2 nd case: CABG x 4	On-pump	RIMA, SVG	Right
20	Pego-Fernandes et al.	2007	Arq Bras Cardiol	Portugal	1	CABG x 5	On-pump	RIMA, SVG	Left
21	Saadi et al.	2007	Rev Bras Cir Cardiovasc	Brazil	1	CABG x 3	On-pump	RIMA, SVG	Left
22	Chakravarthy et al.	2008	Ann Thorac Cardiovasc Surg	India	2	1 st case: CABG x 2	Off-pump	LIMA, LRA, SVG	Right
						2 nd case: CABG x 3	Off-pump	RIMA, SVG	Both sides
23	Yamashiro et al.	2009	Gen Thorac Cardiovasc Surg	Japan	1	CABG x 3	Off-pump	RIMA, LIMA, LRA	Right
24	Murtuza et al.	2010	Tex Heart Inst J	UK	2	1 st case: CABG x 3	On-pump	RIMA, SVG	Left
25	Mujanovic et al.	2011	Medical Archives	Bosnia and Herzegovina	1	CABG x 1	Off-pump	RIMA	Right
26	Kuthe et al.	2011	Gen Thorac Cardiovasc Surg	India	1	CABG x 3 + VSD closure	On-pump	SVG	Right
27	Dabbagh & Bolourian	2011	J Tehran Heart Cent	Iran	1	CABG x 3	Off-pump	RIMA, SVG	Left
28	Xin& Hansong	2015	J Card Surg	China	2	1 st case: CABG x 2	Off-pump	RIMA, SVG	Left
						2 nd case: CABG x 3	Off-pump	RIMA, SVG	Left
29	Kono et al	2016	J Heart Valve Dis	Japan	1	CABG x 1, AVR	On-pump	SVG	Left
30	Subash et al.	2017	Heart Views	India	1	CABG x 2	Not mentioned	RIMA, SVG	Left
31	Zhigalov et al.	2019	Am J Case Rep	Germany	1	CABG x 2	On-pump	RIMA, LIMA	Left
32	Hussain	2021	EC Cardiology	UK	1	CABG x 2	On-pump	RIMA, SVG	Not mentioned
33	Cheng et al.	2021	Asian J Surg	China	1	CABG x 4	On-pump	LIMA, SVG	Not mentioned
34	Oi et al.	2022	J Cardiothorac Surg	Japan	1	CABG x 3	On-pump	RIMA, LIMA, SVG	Left
35	Takahashi & Niino	2022	Jpn J Cardiovasc Surg	Japan	1	CABG x 2	On-pump	RIMA, SVG	Not mentioned

AVR, aortic valve replacement; CABG, coronary artery bypass graft; GEA, gastroepiploic artery; LIMA, left internal mammary artery; LRA, left radial artery; RIMA, right internal mammary artery; RRA, right radial artery; SVG, saphenous vein graft; VSD, ventricular septal defect.

Conclusions

Dextrocardia was the first cardiac malposition to be described by Marco Severino in 1643,⁸ and situs inversus totalis with mirror-image dextrocardia was described by Fabricius in 1606.⁹

A previous study reported percutaneous coronary intervention in a patient following non-ST elevation myocardial infarction.¹⁰ Off-pump CABG has also been reported by many cardiac centers.¹¹⁻¹³

Patients with dextrocardia with situs inversus totalis have a similar life expectancy to healthy individuals, as well as similar risk factors for CAD. The symptoms of angina pectoris in patients with dextrocardia with situs inversus totalis are similar to those of patients with isolated levocardia. As the cardiac autonomic nervous system is a sympathetic trunk at the level of T1-T4/5, some patients experience right-sided chest pain radiating to the right shoulder¹⁴ or the right mandibular region. When performing electrocardiography,

the chest electrodes should be placed in a reversed position rather than normal electrode placement, as the latter results in poor R-wave progression in the chest leads and ST-elevation or ST-depression in line with the myocardial ischemia characteristics, similar to that of patients with a normal cardiac position.

The issues of particular interest in these patients are which vascular conduits should be used to connect to the coronary artery, the most suitable heart-lung support technique, and the surgeon's standing position during the procedure. The right internal mammary artery has been used as a graft conduit to connect to the left anterior descending artery in many reports (Table 1). The right internal mammary artery is suitable for connecting to the left anterior descending artery because the cardiac apex points to the right side of the chest in patients with dextrocardia. Harvesting the left internal mammary artery using the skeletonized technique may extend its length until it can be connected to the left anterior descending artery. However, with this technique, the left internal mammary artery would be positioned under the sternum, making it at risk of being damaged by future surgeries; for example, if the patient requires reoperation on the chest area through median sternotomy incision. In the above-stated two cases, we used the right internal mammary artery to connect to the left anterior descending artery, and the surgical technique was easily conducted.

The on-pump CABG was chosen in these two cases because the team was familiar with this technique but not with dextrocardia. Therefore, everything was managed to have under control except the abnormal cardiac anatomy. CABG in patients with dextrocardia can be performed with the surgeon standing on either side of the patient, according to the surgeon's preference.¹⁵ The decision was made to stand on the right side of the patient in those two cases due to the controllable factors except the abnormal anatomy. The procedure can be performed without any difficulty, similar to that for a patient with a normal anatomy.

Based on the search of MEDLINE via the PubMed interface, 35 studies reporting 41 patients who underwent CABG for dextrocardia between 1981 and 2022 were identified (Table 1). Of the 41 patients who underwent CABG for dextrocardia between 1981 and 2022, the surgeon adopted the standing position in 30 cases. Among these, the surgeon stood on the left side in 19 cases, the right side in 8 cases, and both sides in 3 cases. In all instances, bypass grafts were mentioned, with 33 cases using saphenous vein grafts, 30 using right internal mammary artery grafts, 10 using left internal mammary artery grafts, and 4 using radial artery. Notably, the gastroepiploic artery (GEA) was only used in one case. In patients with situs inversus, variations in the number of grafts were observed, ranging from single-graft procedures (CABG \times 1) to more complex cases involving multiple grafts (CABG \times 5). Surgical techniques demonstrated adaptability, with both on-pump and off-pump approaches utilized across different cases, showcasing the success and flexibility of CABG procedures in addressing the unique anatomical challenges presented by situs inversus.

In summary, two patients with dextrocardia with situs inversus totalis with concomitant CAD were reported. Both patients required surgical treatment, which was performed with on-pump CABG, and both patients achieved good surgical outcomes. It can be concluded that CABG for dextrocardia can be performed in the conventional manner, and the surgeon can perform the operation by standing on their preferred side of the patient.

Ethical Approval: Human Research Ethics Committee Chulabhorn Research Institute
EC 152/2564

Acknowledgment

We thank Emily Woodhouse, PhD, from Edanz (www.edanz.com/ac) for editing a draft of this manuscript.

References

1. Agrawal V, Gupta S. Situs inversus-a not-so-uncommon entity. *Indian J Surg*. 2020 Aug;82: 742-743.
2. Abensur H, Ramires JA, Dalian LA, Jatene A. Right mammary-coronary anastomosis in a patient with situs inversus. *Chest*. 1988 Oct;94 (4):886-887.
3. Folescu R, Motoc A, Zamfir C, Sandu C, Petrescu CI, Şişu AM. Dextrocardia with situs inversus-a clinical and radiological study. *Romanian Journal of Functional & Clinical, Macro & Microscopical Anatomy & of Anthropology*. 2013 Apr;12(2):176.
4. Hynes KM, Gau GT, Titus JL. Coronary heart disease in situs inversus totalis. *Am J Cardiol*. 1973 May;31(5):666-669.
5. Irvin RG, Ballenger JF. Coronary artery bypass surgery in a patient with situs inversus. *Chest*. 1982 Mar;81(3):380-381.
6. Jokinen E. Coronary artery disease in patients with congenital heart defects. *J Intern Med*. 2020 Oct;288(4):383-389.
7. Chikwe J, Lee T, Itagaki S, Adams DH, Egorova NN. Long-term outcomes after off-pump versus on-pump coronary artery bypass grafting by experienced surgeons. *J Am Coll Cardiol*. 2018 Sep;72(13):1478-1486.
8. Bougioukas I, Mikroulis D, Danner B, et al. Coronary artery bypass surgery in a patient with Kartagener syndrome: a case report and literature review. *J Cardiothorac Surg*. 2010 Dec;5:1-4.
9. Larson CP. Situs inversus with other congenital anomalies. *CMAJ*. 1938 Nov;39(5):474.
10. Soofi MA, Pathan A. Percutaneous coronary intervention for acute coronary syndrome in dextrocardia and situs inversus. *JCPSP*. 2007 Dec;17(12):749-750.
11. Tabry IF, Calabrese J, Zammar H, et al. Case report off-pump total myocardial revascularization for dextrocardia and situs inversus. *Heart Surg Forum*. 2001 Sep;4(3):E251-E253.
12. Stamou SC, Bafi AS, Kapetanakis EI, et al. Beating heart surgery in a patient with dextrocardia and complete situs inversus. *J Card Surg*. 2003 Mar;18(2):170-172.
13. Bonanomi G, Kostov D, Zenati MA. Emergent off-pump complete myocardial revascularization in dextrocardia. *J Cardiovasc Surg*. 2004 Feb;45(1):31.
14. Kakouros N, Patel SJ, Redwood S, Wasan BS. Triple-vessel percutaneous coronary revascularization in situs inversus dextrocardia. *Cardiol Res Pract*. 2010 Jan;2010.
15. Saad RA, Badr A, Goodwin AT, Dunning J. Should you stand on the left or the right of a patient with dextrocardia who needs coronary surgery? *Interact Cardiovasc Thorac Surg*. 2009 Oct;9(4):698-702.

Citation

Kanoksin S, Napa-umporn W., Phanchaietch T. Two case reports of coronary artery bypass grafting in adults with dextrocardia with situs inversus. *J Chulabhorn Royal Acad*. 2024; 6(1): 46-53. <https://he02.tci-thaijo.org/index.php/jcra/article/view/259227>

Online Access

<https://he02.tci-thaijo.org/index.php/jcra/article/view/259227>

