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CASE REPORT

Ultrasound-guided carotid angioplasty and stenting in a patient with iodinated contrast allergy: A case report

Le Li, Zi-Yan Wang, Bo Liu

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Abstract

BACKGROUND

Ischemic stroke is an entity with high incidence, morbidity, and mortality rates. Carotid artery stenosis is an important and independent risk factor for ischemic stroke. The three current approaches for treating carotid artery stenosis are drug treatment, carotid endarterectomy (CEA), carotid angioplasty and stenting (CAS). The approach is chosen based on the degree of stenosis. CEA or CAS could have been chosen for the current patient, who had severe carotid stenosis and an iodinated contrast allergy. After thoroughly communicating with the patient, the patient chose CAS for treatment. Therefore, we performed ultrasound-guided CAS to avoid the use of iodinated contrast.

CASE SUMMARY

The main symptoms of the patient were numbness and weakness of the left limb. Computed tomography angiography of the head and neck at another hospital indicated multiple sites of stenosis in the arteries of the head and neck. The patient requested CAS for treatment but was allergic to iodinated contrast media. Thus, routine digital subtraction angiography (DSA) with iodinated contrast could not be used for the procedure. The diagnosis of this patient was as follows: (1) Right parietal lobe cerebral infarction; (2) multiple sites of stenosis in the arteries of the head and neck (severe stenosis of the right internal carotid artery, severe stenosis of the right subclavian artery); (3) right subclavian steal syndrome; and (4) hypertension (stage 3, high risk). The interventions included routine treatment for cerebral infarction, oral administration of clopidogrel (75 mg qd) and aspirin (100 mg qd), ultrasound-guided CAS, and postoperative follow-up. Postoperative color Doppler ultrasound and cerebrovascular magnetic resonance

angiography of the carotid artery showed good vascular recovery, and the postoperative follow-up indicated a good prognosis.

CONCLUSION
This case study suggests that ultrasound-guided endovascular treatment is a potential option for patients with contraindications to the iodinated contrast agents used in DSA-guided surgery, although excellent surgical operating skills are needed.

Key Words: Iodinated contrast allergy; Ultrasound-guided; Gadolinium-based contrast agent; Carotid angioplasty and stenting; Subclavian artery angioplasty and stenting; Digital subtraction angiography; Case report

Core Tip: We report a case of patient who had severe stenosis of the right internal carotid artery and severe stenosis of the right subclavian artery. The patient requested carotid angioplasty and stenting (CAS) for treatment but was allergic to iodinated contrast media. Therefore, we performed ultrasound-guided CAS to avoid the use of iodinated contrast. Ultrasound and magnetic resonance examination showed good vascular recovery, and the postoperative follow-up indicated a good prognosis. The case suggests that for patients who are allergic to iodinated contrast media, ultrasound-guided CAS is a feasible alternative.

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INTRODUCTION

Ischemic stroke is a common life-threatening disease, with high morbidity and mortality rates in China. Carotid artery stenosis is an important and independent risk factor for ischemic stroke. With the advancement of materials science, interventional techniques, and imaging technology, as well as the application of distal protection devices, carotid angioplasty and stenting (CAS) has been applied for the treatment of carotid artery stenosis, especially in high-risk patients, to improve the blood supply of the intracranial artery and prevent the occurrence of stroke. The C-arm fluoroscopy machine is the main equipment used in CAS. Iodinated contrast media is used in digital subtraction angiography (DSA)–guided surgical operations, giving the interventional physician a way to observe local blood vessels in real time in an intuitive way and facilitating successful treatment. However, CAS is not clinically applied in patients with iodinated contrast allergy.

For this reason, with the approval of the Quality Management Committee of our hospital, we performed ultrasound-guided CAS in a patient with a contrast agent allergy and achieved a good outcome. We report this case and review the relevant literature.

CASE PRESENTATION

Chief complaints

A 55-year-old man was admitted to our hospital due to numbness and weakness of the left limb for a month.

History of present illness

The patient was admitted to a local hospital for numbness and weakness in his left limb for a month and was diagnosed with cerebral infarction. After standard treatment, the patient felt that the numbness and weakness in his left limb had improved. He occasionally felt weakness of the limb that would resolve spontaneously. Skin rash and shock developed due to an allergic reaction to iodine when he was undergoing head and neck computed tomography angiography (CTA) at the local hospital. The hospital's management brought him out of the crisis. At that time, valuable head and neck artery images were obtained that showed multiple sites of stenosis in cerebral arteries. To better solve this problem, he was transferred to our hospital.

History of past illness

The patient reported well-controlled hypertension. He denied other systemic diseases such as diabetes, hyperlipidemia, coronary heart disease, hepatitis, and tuberculosis.

Personal and family history

The patient reported no smoking or drinking, and there was no special family history.

Physical examination

Physical examination showed the following: clear mind, fluent language, limb muscle strength level 5, and NIHSS score 0.

Laboratory examinations

There were no significant abnormalities in laboratory examinations.

Imaging examinations

Brain magnetic resonance imaging at our hospital showed multiple small patchy shadows on the right parietal lobe, most of which were deemed cerebral infarctions (new onset). Head and neck CTA performed at the local hospital showed that the V1 segment of the right vertebral artery was occluded, the lumen of the rest of the right vertebral artery was small, and the proximal segment of the right subclavian artery (R-SCA) and the right carotid sinus were severely stenotic (Figure 1G and Figure 2G-J). Carotid artery color Doppler ultrasound showed plaque formation in the bilateral common carotid artery, internal carotid artery (ICA), artery-SCA, brachiocephalic artery, and right vertebral artery; stenosis in the initial segment of the right internal carotid artery (R-ICAC1) (stenosis rate 80%) (Figure 2A) and initial segment of the R-SCA (stenosis rate 80%) (Figure 1A), and R-SCA steal syndrome (partial). There was no obvious blood flow signal in the initial segment of the right vertebral artery, suggesting occlusion.

FINAL DIAGNOSIS

The diagnosis of this patient was as follows: (1) Right parietal lobe cerebral infarction; (2) multiple sites of stenosis in the arteries of the head and neck (severe stenosis of the right internal carotid artery, severe stenosis of the right subclavian artery); (3) right subclavian steal syndrome; and (4) hypertension (stage 3, high risk).

TREATMENT

Routine treatment for cerebral infarction was given to the patient after admission. To treat the multiple stenoses of the head and neck arteries, the patient and his family chose CAS (R-SCA, R-ICAC1) after fully understanding the available options. However, routine endovascular therapy could not be performed due to his iodinated contrast agent allergy. The interventional treatment team discussed the problem and decided to use ultrasound instead of iodinated contrast to locate and visualize local cerebral blood vessels.Then, ultrasound-guided CAS of the R-ICAC1 and the R-SCA was performed.

Oral clopidogrel (75 mg qd) and aspirin (100 mg qd) were administered before surgery. The surgical procedure was as follows: (1) The operative fields for the right radial artery and right femoral artery were disinfected and draped. Under local anesthesia, the Seldinger technique was used to puncture the right radial artery and right femoral artery with a 6-F radial artery access sheath and an 8-F femoral artery access sheath, respectively; (2) Under the guidance of a 5-F pigtail angiographic catheter, a 260-cm-long 0.035" guidewire was inserted from the right radial artery sheath to the right femoral artery sheath. A snare was used to grab the tip of the 260-cm 0.035" guidewire out of the femoral artery sheath to form a stable 0.035" stent placement track with both ends outside the body. A 10 mm × 25 mm Biotronik stent was delivered to the beginning of the R-SCA through the femoral artery sheath over the 0.035" guidewire and deployed in a proper position under ultrasound guidance (Figure 1E and F). Ultrasonography showed that the blood flow of the R-SCA was significantly improved (Figure 1B and D) (the degree of stenosis changed from 80% to 30%) (Figure 1A and C). The stent delivery system and the 260-cm 0.035" guidewire were withdrawn. The radial artery access sheath was removed, and the access site was compressed for hemostasis; (3) An 8-F guide catheter was inserted into the right common carotid artery over a 0.035" guidewire. Ultrasonography and radiography showed that the tip of the guide catheter was positioned accurately (Figure 2E). Ultrasonography showed that the degree of stenosis of R-ICAC1 was approximately 80% (Figure 2A). Under ultrasound and X-ray guidance, the 5-mm eV3 embolic protection device (EPD) was placed at the distal R-ICAC1 segment. A 6-8 mm × 40 mm eV3 self-expanding stent was placed in the stenotic site over the 0.014" guidewire of the EPD and deployed when ultrasonography showed accurate positioning (Figure 2E and F). The degree of residual stenosis was 30% (Figure 2C). The distal blood flow was significantly improved (Figure 2D). The stent delivery system and the EPD were withdrawn. The femoral artery access sheath was removed, and the access site was compressed for hemostasis at the end of the procedure; and (4) The patient's vital signs were stable during the operation, and no particular discomfort was reported. Routine care for carotid artery stent implantation was given after surgery.

OUTCOME AND FOLLOW-UP

The patient was discharged without any symptoms or positive neurological signs and had an NIHSS score of 0. The

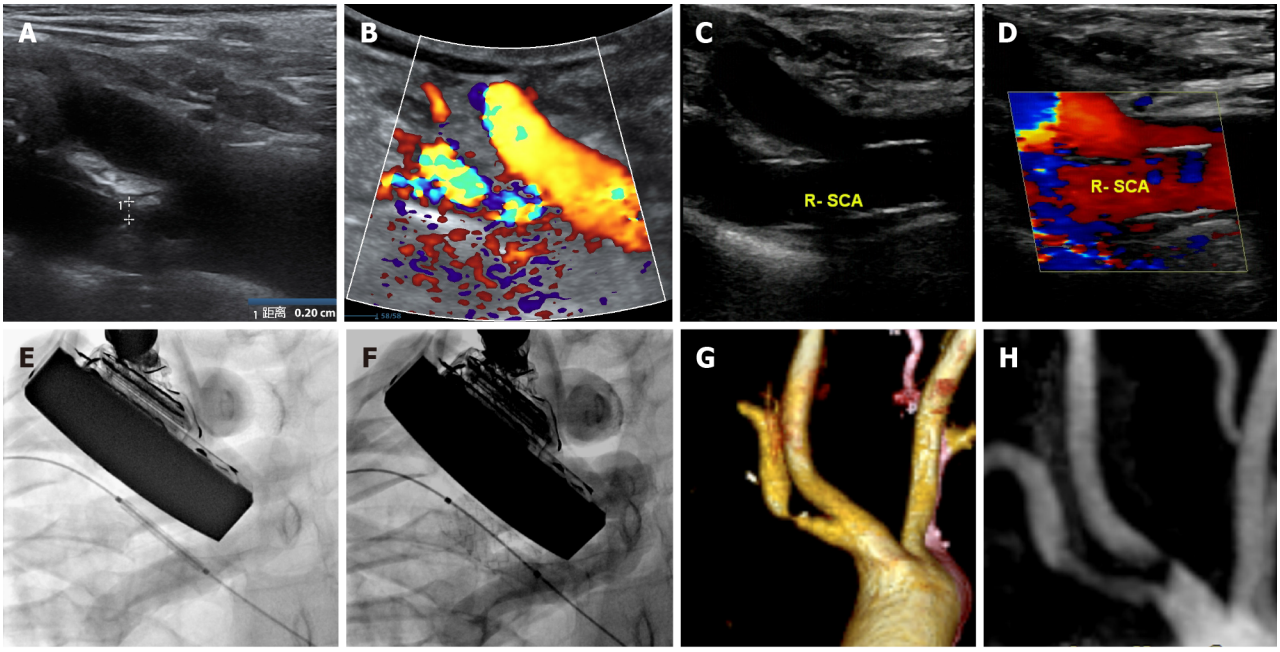

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Figure 1 Images before and after subclavian artery stent implantation. A: Ultrasound showing stenosis of the right subclavian artery (R-SCA) before surgery; B: Ultrasound showing blood flow in the region of R-SCA stenosis before surgery; C: Ultrasound showing good stent shape of the R-SCA after surgery; D: Ultrasound showing good blood flow in the region of R-SCA stent after surgery; E: X-ray showing the shape of the stent before stenting; F: X-ray showing the shape of the stent after stenting; G: Computed tomography angiography showing severe stenosis of the R-SCA before surgery; H: Magnetic resonance angiography showing good stent shape after surgery. R-SCA: Right subclavian artery.

follow-up carotid color Doppler ultrasound and cerebrovascular magnetic resonance angiography (MRA) showed normal stent shape and function (Figure 1H and Figure 2K), and the patient's intracranial blood supply was restored (Figure 1D and Figure 2D). Double antiplatelet therapy was continued for 6 mo after stent placement, and then single antiplatelet therapy with clopidogrel was continued lifelong. After 2 years of follow-up, the patient's general condition was good, and no stroke occurred (modified Rankin Scale (mRS) score 0).

DISCUSSION

Advantages and disadvantages of this case study

Advantages: The patient in this study was allergic to iodinated contrast media, which is an absolute contraindication for CAS. In this case, the surgeon avoided the use of iodinated contrast and instead used ultrasound for stent positioning and completion of the operation. Carotid artery color Doppler ultrasound and cerebrovascular MRA showed good vascular recovery after the operation. According to relevant literature in China and abroad, ultrasound-guided interventional therapy can now be applied to treat diseases including coronary artery disease, liver carcinoma, kidney disease, and uterine fibroids. Among cerebrovascular treatments, ultrasound-guided interventional therapy is not common, but it is technically safe and feasible. Reports about carotid artery occlusion and low-dose contrast media for patients with renal insufficiency are available, but arterial stent implantation under ultrasound guidance has not been reported. Therefore, this operation is a technical innovation and can be applied in patients with contraindications to iodinated contrast agents for various reasons.

Shortcomings: The operation was successful because there were no complications or adverse events during the operation, such as arterial wall damage, spasm, plaque detachment, thrombosis, or stent displacement. Moreover, balloon predilation and postdilation were not performed (these can easily cause plaque detachment and embolism). Ultrasound and fluoroscopy alone without contrast cannot be used to completely and accurately detect these unexpected conditions. Therefore, DSA with contrast must be used to observe the local and distal conditions of the artery to make a correct diagnosis and choose the best treatment. If an iodinated contrast agent had been used, another allergic reaction might have occurred, which was a risk the patient could not take. An iodinated contrast agent allergy also increases the difficulty of dealing with various unexpected situations and may eventually cause failure of the operation, threatening the life of the patient. We covered all of these considerations in the preoperative discussion and developed a back-up plan: (1) Effective preoperative preparation was performed to ensure the smooth execution of the operation. To reduce the risk, balloon predilation and postdilation were not performed; and (2) In the case iodinated contrast needed to be used, a large dose of corticosteroids would be intravenously administered in advance to reduce the strength of the allergic reaction, and the patient would be closely monitored to gain time to deal with other unexpected conditions.

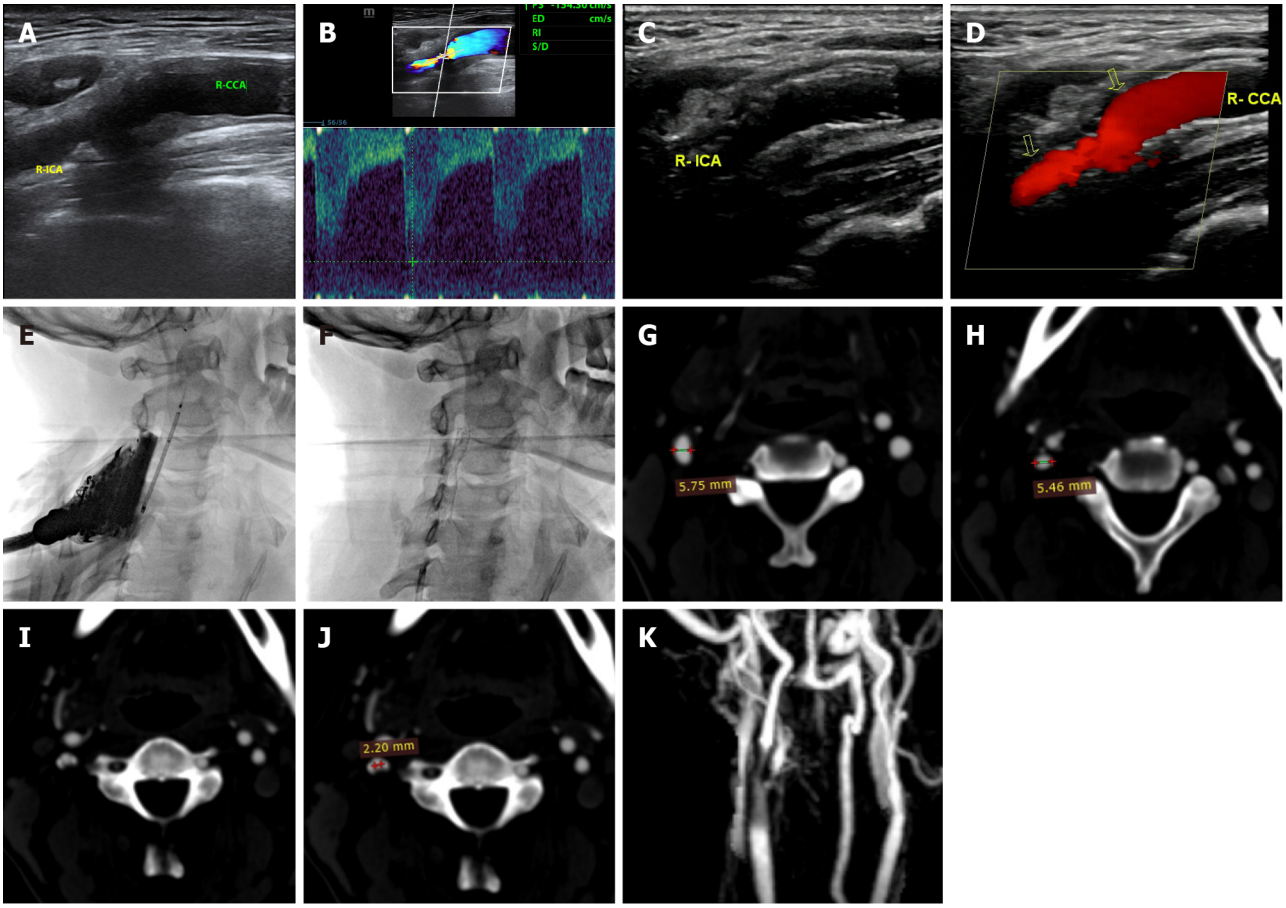

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Figure 2 Images before and after carotid artery stent implantation. A: Ultrasound showing stenosis of the right internal carotid artery (R-ICA) before surgery; B: Ultrasound showing blood flow in the region of R-ICA stenosis before surgery; C: Ultrasound showing good stent shape of the R-ICA after surgery; D: Ultrasound showing good blood flow in the region of R-ICA stent after surgery; E: X-ray showing the shape of the stent before stenting; F: X-ray showing the shape of the stent after stenting; G: Preoperative computed tomography angiography (CTA) showing a proximal diameter at the site of R-ICA stenosis of 5.75 mm; H: Preoperative CTA showing a distal diameter at the site of R-ICA stenosis of 5.46 mm; I: CTA showing a cross-section of the site of R-ICA stenosis. The vascular lumen is in the middle, and calcified plaques are present at both ends; J: CTA indicating a lumen diameter at the site of R-ICA stenosis of 2.20 mm; K: Magnetic resonance angiography showing good stent shape after surgery. R-SCA: Right subclavian artery; R-ICA: Right internal carotid artery.

Critical points of technologies: There are two critical points. (1) Identify the narrowed portioned from sonography; and (2) Pass the guidewire through the narrowed portion of the artery. If the guidewire cannot pass through the narrowed portion of the artery, implantation of the stent is impossible. Since both the initial segment of the R-SCA and the initial segment of the R-ICAC1 are thick (8-11 mm), shallow, and not covered by bone, color ultrasound can clearly show these blood vessels and accurately locate the site of stenosis. Ultrasound can detect plaque and blood flow in real-time, and is advantageous in that it is non-invasive, repeatable, and radiation-free. It is often difficult for the guidewire to pass through the stenosis when the stent is placed at the initial segment of the R-SCA through the regular femoral artery approach. This procedure was possibly more difficult because no contrast agent was used in this patient. To overcome this difficulty, we chose the right radial artery approach. Under the guidance of ultrasound and fluoroscopy, the 260-cm-long 0.035" guidewire easily passed through the stenosis of the R-SCA. Then, under the guidance of fluoroscopy, the 260-cm-long 0.035" guidewire was inserted into the right 8F femoral artery sheath, and the head of the guidewire was captured outside the body. This provided a stable track for the 10 mm × 25 mm stent from the femoral artery approach to the stenosis of the R-SCA, and then the stent was precisely and successfully placed under ultrasonic guidance. In this patient, the rate of stenosis in the initial segment of the R-ICAC1 was 80%. Because the degree of stenosis was less than 90%, under the guidance of ultrasound and fluoroscopy, the 0.014 '' micro guidewire easily passed through the stenosis area, and then the stent was successfully placed. If the degree of stenosis is greater than 90% or the lesion is occluded, only ultrasound and fluoroscopy are used, no contrast agent is used for evaluation, passing the guidewire through the stenosis lesion may be relatively difficult, and the surgery may fail.

Treatment selection for symptomatic carotid artery stenosis

Most carotid artery stenosis is caused by atherosclerosis. Lumen stenosis or occlusion, plaque rupture, and embolism can lead to ischemic stroke. There are currently three approaches for treating carotid artery stenosis: medical drug therapy, CEA and CAS. The North American Symptomatic Carotid Endarterectomy Trial and the European Carotid Surgery Trial

have defined a degree of carotid artery stenosis of 0%-49% as no or mild stenosis, 50%-69% as moderate stenosis, 70%-99% as severe stenosis, and 100% as complete occlusion. Patients with moderate stenosis should be closely observed for progression of the lesion, and patients with severe stenosis or occlusion and symptomatic patients should undergo surgery or interventional treatment. That being said, accurate diagnosis of the degree of stenosis is essential[1,2]. In patients with symptomatic carotid artery stenosis and low perioperative risk, when the degree of stenosis exceeds 50%, revascularization should be performed as soon as possible[3].

The patient in the present case had severe carotid artery stenosis, so CEA and CAS were his options. Both methods have advantages and disadvantages. CAS has the advantages of less trauma, fewer surgical complications, high safety, and a high success rate. However, CAS cannot be performed in patients who are allergic to contrast media or have severe heart, liver, or kidney dysfunction; patients in whom interventional devices cannot be placed due to severely tortuous interventional pathways and/or mural thrombosis and vulnerable plaques; patients with chronic complete carotid artery occlusion, in whom contrast media cannot pass; or patients with cerebral hemorrhage within the last 3 mo or large-area cerebral infarction within the last 4 mo. There has been controversy about the pros and cons of the two treatments. According to the results of prospective controlled studies, the consensus of experts is that CAS is a treatment that is not inferior to CEA and can be selectively applied in those with a high surgical risk. CEA has advantages for patients over 75 years of age with severe calcification and thrombosis in the aortic arch and symptomatic carotid stenosis. Current evidence indicates that CEA is absolutely preferred for carotid artery stenosis. In terms of postoperative safety and long-term postoperative efficacy, CEA still has advantages and is still the gold standard for the treatment of carotid artery stenosis. The efficacy of CAS is not superior to that of CEA. However, CEA has become an indispensable treatment for some high-risk patients[4]. CEA was a suitable procedure for treating carotid artery stenosis in this patient but could not be used to manage the stenosis of the R-SCA at the same time. Therefore, CAS was performed at the request of the patient and his family members.

Alternative for patients with iodinated contrast allergy

According to the relevant literature, if iodinated contrast agents cannot be used, such as in patients who are allergic to iodinated contrast agents and those who have a clear history of hyperthyroidism, gadolinium (Gd)-based contrast is feasible as an alternative. The incidence of all side effects of Gd-based contrast media is 1%-2%, while the incidence of all side effects of iodinated contrast media is 3.0%, although the incidence of serious life-threatening side effects of Gd-based contrast media is 10 times that of iodinated contrast media. The probability of severe allergic reaction to gadopentetate meglumine is 0.0002% to 0.001%[5], but it is 3 or 4 times this in patients with a history of iodine allergy, which is still quite low[6]. At present, Gd is mainly used as an MR contrast agent in clinical applications. Gd, as an alternative contrast agent for patients with contraindications to iodinated contrast agents, is mainly used in intravenous pyelography, enhanced computed tomography (CT), CTA, DSA, and interventional therapy. Researchers in China and abroad have reported the successful clinical application of Gd-based contrast agents such as gadopentetate meglumine in pulmonary, aortic, and coronary CTA[7-9]. In 1993, Kinno *et al*[10] first reported the use of a Gd-based contrast agent in arterial angiography and interventional therapy. Since then, the application of Gd-based contrast agents in the cerebral artery, coronary artery, carotid artery, aorta, renal artery, hepatic artery, limb arteries, vena cava, and other blood vessels in most parts of the body has yielded good imaging results[7,11-14]. Moreover, the current application of Gd-based contrast in intracerebrovascular interventional therapy is still associated with some problems, such as high cost and unclear potential for neurotoxic effects, although much evidence has shown that it is safe for the nervous system. Gd-diethylenetriamine pentetic acid (Gd-DTPA) cannot pass through the intact blood–brain barrier. There are currently no guidelines for intra-arterial Gd administration. The maximum safe dose of intra-arterial injection has not yet been determined. The safety of intracardiac and intracoronary injection needs to be further clarified.

Patients who are unable to undergo CAS due to contrast agent-related reasons can undergo CAS under ultrasound guidance. Rostambeigi *et al*[15] reported a case of intravascular revascularization with the aid of duplex ultrasound for chronic internal carotid artery occlusion. Chinese researcher Lu *et al*[16] reported revascularization in two cases of chronic internal carotid artery occlusion by intravascular intervention under ultrasound monitoring. For patients allergic to iodinated contrast media, although ultrasound-guided CAS is an option, it has the disadvantage that ultrasound can only display the vessel approximately 4-5 cm above the bifurcation of the common carotid artery. Thus, excellent surgical operating skills are required[16].

Emphasis

This case study suggests that for patients who are allergic to iodinated contrast agents, ultrasound-guided CAS is a feasible alternative. However, the feasibility is conditional; that is, the lesion must be easy to manage and associated with low risk. For patients with difficult-to-manage lesions, advanced age, or higher surgical risk, who are prone to complications after surgery, CEA is preferred when both CAS and CEA are options.

CONCLUSION

Ultrasound-guided CAS is technically a feasible procedure. However, due to the few patients who have been treated in this way, the limited treatment experience, and the lack of recognized indications, the long-term efficacy needs further observation, and more cases are needed to confirm the outcomes. We believe that with further improvement of this technique, careful selection of patients, and appropriate preoperative evaluation, ultrasound-guided endovascular therapy will benefit more patients with contraindications to iodinated contrast agents and will become a viable option in

the future.

FOOTNOTES

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