

## Bypass Surgery in Arterial Thoracic Outlet Syndrome

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Arterial thoracic outlet syndrome (TOS) causes ischemic symptoms; it is the rarest type, occurring in 5% of all TOS cases. This paper is a case report of a 38-year-old male patient diagnosed with arterial TOS, displaying symptoms of acute critical limb ischemia caused by thromboembolism. Brachial artery of the patient has been diffusely damaged by repeated occurrence of thromboembolism. It was thought to be not enough only decompression of subclavian artery to relieve the symptoms of hand ischemia; therefore, bypass surgery using reversed great saphenous vein was performed.

Key words: 1. Thoracic outlet syndrome  
2. Vascular grafting  
3. Thromboembolism

### CASE REPORT

A 38-year-old man was admitted to the emergency room with sudden-onset severe resting pain in his right arm. A year before, the patient had complained of right shoulder pain, radiculopathy of the right arm, and coldness of the right hand, and was diagnosed with arterial thoracic outlet syndrome (TOS) at that time. He refused a recommendation for surgery and chose to be treated with rehabilitation instead. On his subsequent admission to the emergency room, the patient's physical examination showed ischemia of the right hand along with diminished radial and brachial arterial pulses. There was an acute occlusion caused by an embolism in the distal brachial artery, and the right subclavian artery was patent in anatomical position. When the patient was in abduction position with an angle of more than 90 degrees, total occlusion of the right subclavian artery was observed (Fig. 1). Initial lab findings were not significant.

Emergency surgery was performed on the patient. Under local anesthesia, a transverse skin incision was made in the right antecubital fossa, after which embolectomy of the brachial artery was performed using a Fogarty balloon catheter. Due to the absence of backflow, another incision was made in the wrist in order to approach the radial artery for embolectomy. The operation had to be discontinued when Doppler ultrasound confirmed continuity of the palmar arch. After surgery, the patient's arm was maintained in the adduction position. The next day, the patient complained of severe pain in his right arm, and pulses were completely absent in the brachial and radial arteries. Angiography revealed that the occlusion in the lower part of the brachial artery had recurred at the same site (Fig. 2). Unobstructed blood flow was observed following a percutaneous mechanical suction thrombectomy. However, reoperation seemed inevitable, since progressive ischemia of the right arm was observed as soon as four hours after the thrombectomy. The reoperation was ini-

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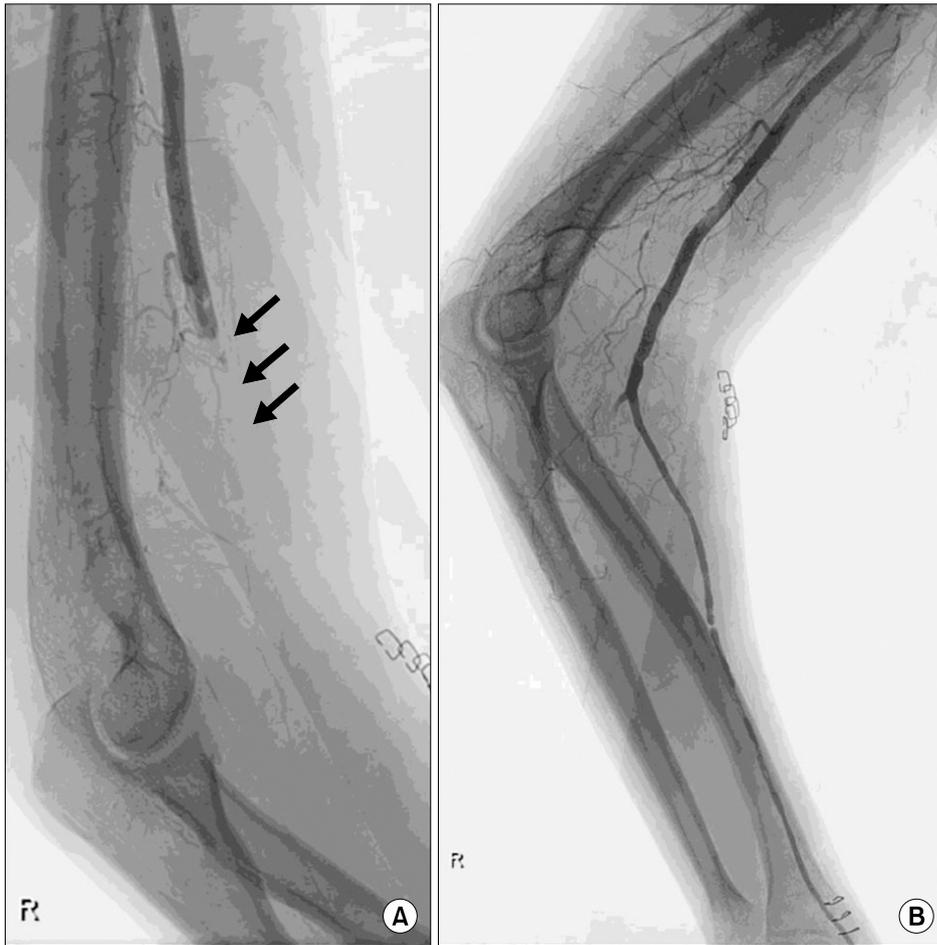
**Fig. 1.** (A) Conventional angiography in anatomical position showed that the blood flow of the right subclavian artery was patent without any stenosis or aneurysm. (B) However, an acute occlusion was caused by embolism in the distal brachial artery (arrow points to the occluded brachial artery). (C) When the patient was in abduction position with an angle of more than 90 degrees, the right subclavian artery was completely occluded (arrow points to the occluded right subclavian artery).

tiated with a transverse incision one fingerbreadth above the right clavicle. The medial half of the right clavicle was disarticulated from the sternum, and a resection of the clavicle was performed in order to expose the proximal portion of the right subclavian artery. Resection was also hoped to result in decompression. Inflammation surrounded the impinged area of the right subclavian artery. The great saphenous vein, harvested from the left leg, was reversed and used for a bypass conduit. The proximal anastomosis was performed in an area of the right subclavian artery more proximal than the compressed area, and the distal anastomosis was performed at the radial artery by making a subcutaneous tunnel up to the incision point in the wrist and passed through the subcutaneous tunnel. Angiography taken in anatomical position after the surgery showed that the blood flow from the right subclavian artery to the native brachial artery was maintained, as well as the blood flow of the radial artery from the right subclavian artery through the reversed great saphenous vein conduit in abduction position (Fig. 3). Persistent vasospasm of the palmar arch was evaluated. Coldness and tingling sensations also continued; consequently, right T3 sympathectomy was performed three days later using video-assisted thoracoscopic

surgery. The patient took warfarin and aspirin for three months following the surgery, after which he was maintained on aspirin alone. Upon discharge, the patient received rehabilitation therapy for decreased motor function, decreased sensation, and tingling sensations, recovering after eight months of therapy. The patient was unable to carry out everyday tasks at work before surgery, but one month after surgery, he was able to return to his job and has been working since then with no difficulties.

## DISCUSSION

The thoracic outlet is an anatomical region formed by the anterior scalene muscle, middle scalene muscle, and the first rib together with its surrounding structures. The subclavian artery, subclavian vein, and five nerve branches of the brachial plexus pass through this region. Compression of these vessels and nerves causes clinical problems, which are known as TOS. TOS can be categorized into arterial, venous, and neurogenic TOS, based on the structure that is compressed. The most common type is neurogenic TOS, while arterial TOS, which causes ischemia of the extremities, is the rarest



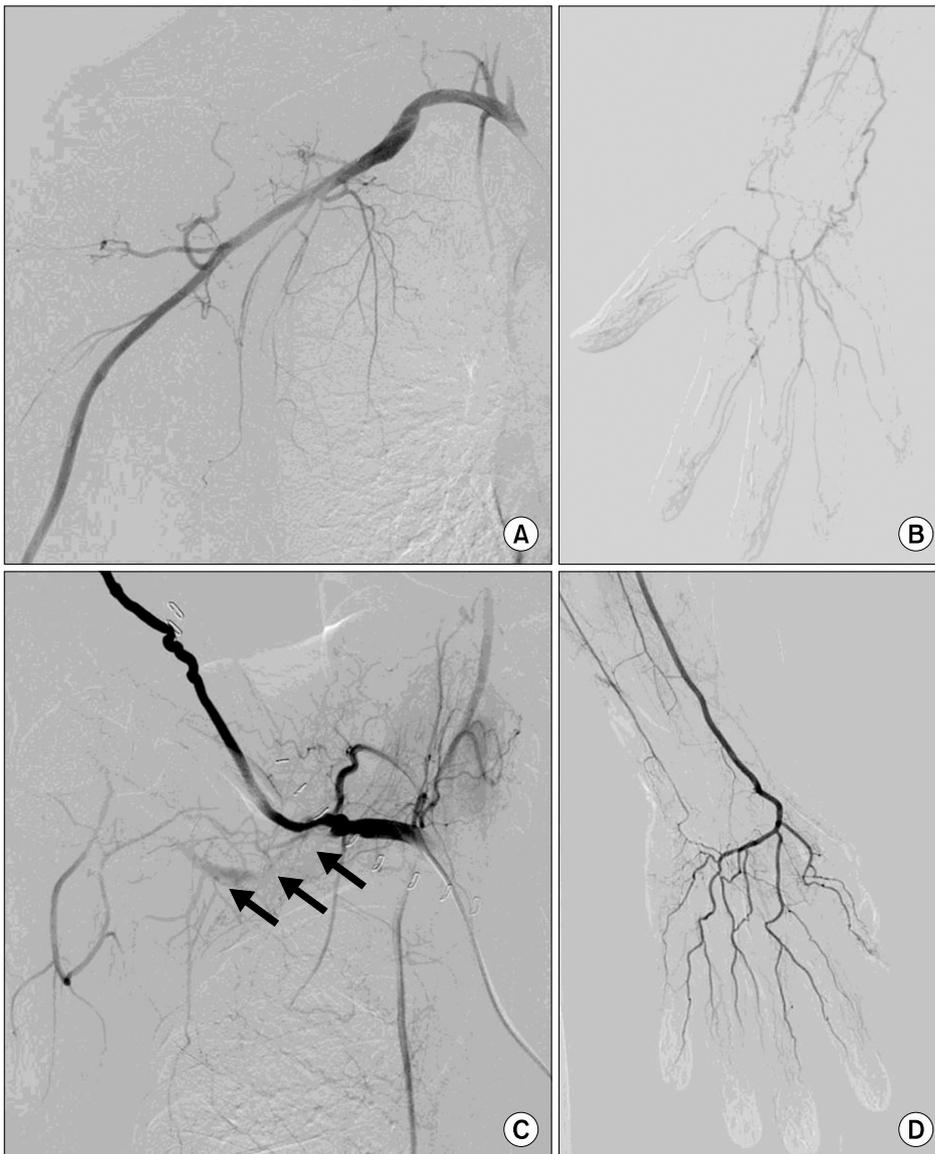
**Fig. 2.** (A) Angiography revealed that the reocclusion of the lower part of the brachial artery recurred at the same site (arrows point to the reoccluded brachial artery). (B) Following a percutaneous mechanical suction thrombectomy, unobstructed blood flow was obtained.

type and comprises <5% of all cases of TOS [1]. Compared to the symptoms of neurogenic TOS, the symptoms of arterial TOS have better outcomes after surgical treatment, and they rarely remain present or recur. However, arterial TOS may also lead to upper limb amputation or cerebral infarction, as has been reported in 0% to 5% of cases [2].

Approximately 88% of cases involving the compression of the subclavian artery are attributed to bony abnormalities of the cervical rib or the first rib, which are mostly due to adhesions of the cervical rib or first rib involving a fibrous band. Cases showing symptoms related to postural change in the absence of embolism and aneurysm are less frequent [3]. Of such cases, 48% to 64% are diagnosed after the emergence of lesions in the lumen of the artery or embolism arising from aneurysms. The extent of embolism is significant for the outcome of surgical treatment, and widespread embolism may lead to amputation of the limb [4].

Decompression in TOS involves the resection of the cervical rib, all soft tissue that contributes to the compression, and the first rib. Moreover, recent reports have discussed the partial or complete resection of the clavicle in order to achieve decompression [4-6]. As in our case, medial claviclectomy was performed, exposing the artery in order to promptly restore blood flow after acute critical ischemia. The authors of the above study agreed that medial claviclectomy took less time and did not require other skin incisions, unlike resection of the first rib. Claviclectomy was hoped to achieve decompression, but did not succeed.

According to reports made during the surgery, recurring embolism in the brachial artery had caused diffuse damage to the lumen of the artery. Since the resection of the first rib to decompress the subclavian artery did not seem likely to alleviate the damage in the brachial artery, the operation did not involve the resection of the first rib when the bypass was



**Fig. 3.** (A) Angiography taken in anatomical position after the surgery showed that blood flow to the native brachial artery from the right subclavian artery was maintained. (B) Palmar circulation was achieved through ulnar collaterals. (C, D) Angiography taken in abduction position showed blood flow of the radial artery to the palmar arch from the right subclavian artery through the reversed great saphenous vein conduit. The arrows in C point to the subclavian artery, which does not show any contrast on the image.

performed.

Embolectomy or bypass surgery for treating recurring embolism, as shown in our patient, did not resolve the problem of insufficient blood flow to the hands. Persistent vasospasm did not respond well to medical treatment, but better results were anticipated to result from sympathectomy [7]. Right T3 sympathectomy was performed through video-assisted thoracoscopic surgery on the third day after surgery, and the symptoms subsided as expected.

Studies have shown that a longer duration of arterial TOS results in damage to the distal and right subclavian arteries.

In such situations, it does not suffice to simply remove the proximate cause through embolectomy, because it is highly probable for embolism to recur from the already-damaged lumen of the distal artery [8]. Therefore, it is best for arterial TOS to be diagnosed promptly and to be treated appropriately. Moreover, the approach to treatment must be adjusted corresponding to the duration of the morbidity. In particular, bypass surgery is recommended for cases of recurring embolism.

In this case, critical limb ischemia, which had occurred despite several embolectomies, required prompt revascularization.

Medial claviculectomy did not suffice to decompress the subclavian artery, but it was helpful in ensuring good visibility for a fast and accurate operation.

The risk is low that ischemia will recur in the arm of the patient in our case; however, persistent compression may cause an aneurysm in the right subclavian artery, and additional surgery might be necessary in the future.

### CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

### ACKNOWLEDGMENTS

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