



Transcarotid Artery Revascularization (TCAR)

Neuroanesthesia Quiz #87

[Start](#)

Quiz Team

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CONTENT OUTLINE

Please click on any of the following links to proceed to that question/topic.

Question 1: [Procedure overview](#)

Question 2: [Anatomic eligibility](#)

Question 3: [Advantages of TCAR over transfemoral carotid artery stenting](#)

Question 4: [Intraoperative management](#)

Question 5: [Periprocedural risk of stroke](#)

QUESTION 1

A 69 y/o M with h/o stroke is considered high risk for carotid endarterectomy. Transcarotid artery revascularization (TCAR) is recommended. Which of the following statements regarding TCAR is **TRUE**?

Please click on any of the following links to proceed to that question/topic.

A. [TCAR is an endovascular procedure without neck incision](#)

B. [Carotid artery cross-clamping is not needed during TCAR](#)

C. [Blood flow is reversed from carotid artery to femoral artery during TCAR](#)

D. [Carotid flow reversal continues after the stent is deployed](#)

[Content Outline](#)

[Q2, Q3, Q4, Q5](#)

Sorry! Incorrect.

Click to Return to
Question

EXPLANATION

A. TCAR is an endovascular procedure without neck incision

This statement is false.

TCAR is a hybrid surgical and endovascular intervention for patients considered high risk for carotid endarterectomy (CEA) due to significant comorbidities. Compared to transfemoral carotid artery stenting (TFCAS), TCAR may eliminate those causes of periprocedural embolic stroke associated with TFCAS.

A neck incision is made above the clavicle during TCAR, which is much smaller than the incision made during open CEA ([Figure 1](#)). TCAR involves dissection of the proximal common carotid artery (CCA) with the insertion of a short sheath that stays proximal to the carotid bifurcation. The carotid sheath is then connected to a femoral vein sheath through a shunt which has a filter device ([Figure 2](#)).

Ankam A, et al. Anesthetic Considerations for Transcarotid Artery Revascularization: Experience and Review of Forty Cases From a Single Medical Center. *Cureus*. 2020 Dec 24;12(12):e12250.

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[Click to Return to Question](#)

EXPLANATION

B. Carotid artery cross-clamping is not needed during TCAR

This statement is false.

To establish carotid flow reversal, the common carotid artery is clamped proximal to the insertion of the carotid sheath. It is critical to maintain a patient's blood pressure to facilitate collateral blood flow through the circle of Willis to prevent cerebral hypoperfusion.

Ankam A, et al. Anesthetic Considerations for Transcarotid Artery Revascularization: Experience and Review of Forty Cases From a Single Medical Center. Cureus. 2020 Dec 24;12(12):e12250.

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EXPLANATION

C. Blood flow is reversed from carotid artery to femoral artery during TCAR

This statement is false.

The femoral vein (not femoral artery) is at low-pressure compared to the carotid artery. During TCAR, carotid blood flows in a reverse direction from the brain to the carotid artery to the femoral vein through the shunt. During this reversal of flow, any plaque or thrombotic debris is collected at the filter, which eliminates the risk of debris entering the brain to cause embolic stroke. Once the carotid blood flow is reversed, the carotid lesion is then crossed with a wire and treated with angioplasty and stenting.

Ankam A, et al. Anesthetic Considerations for Transcarotid Artery Revascularization: Experience and Review of Forty Cases From a Single Medical Center. Cureus. 2020 Dec 24;12(12):e12250.

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Click to Return to
Question

[Next Question](#)

EXPLANATION

D. Carotid flow reversal continues after the stent is deployed

This statement is true.

Following carotid stent placement, 2 to 3 additional minutes of carotid flow reversal is allowed to retrieve any additional debris resulting from the intervention.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

QUESTION 2

Safe placement of the FDA-approved flow reversal device is dependent on several anatomic factors. Which of the following statements regarding the anatomic eligibility for TCAR is **FALSE**?

Please click on any of the following links to proceed to that question/topic.

A. [Inadequate clavicle to carotid bifurcation distance is the most common anatomic limitation](#)

B. [Carotid stenting is not advised for carotid lesions with significant calcification](#)

C. [The depth of common carotid artery does not affect the procedural risk](#)

D. [The size of carotid artery is important for use of flow reversal device](#)

[Content Outline](#)

[Q1, Q3, Q4, Q5](#)

Sorry! Incorrect.

[Click to Return to Question](#)

EXPLANATION

A. Inadequate clavicle to carotid bifurcation distance is the most common anatomic limitation

This statement is true.

All patients being considered for TCAR should undergo preoperative CTA imaging of the carotid vessels to determine anatomic eligibility. The most common reason for not meeting the device's requirements is an insufficient distance between the clavicle and carotid bifurcation, which should be ≥ 5 cm.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

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EXPLANATION

B. Carotid stenting is not advised for carotid lesions with significant calcification

This statement is true.

Carotid stenting is not advised for carotid lesions with bulky or circumferential calcification due to high procedural risks and inadequate stent expansion. Up to 7% of carotid arteries are ineligible for carotid stenting due to excessive circumferential calcification burden of the lesion.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

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Click to Return to
Question

EXPLANATION

C. The depth of common carotid artery does not affect the procedural risk

This statement is false.

The depth of common carotid artery (CCA) is an important consideration. Accessing a CCA with extended depth is technically more challenging. The risk of carotid artery injury may be increased and higher CCA punctures above the clavicle may occur given the angle and trajectory needed for the access.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

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[Click to Return to Question](#)

[Next Question](#) 

EXPLANATION

D. The size of carotid artery is important for use of flow reversal device

This statement is true.

According to the flow reversal device's instructions for use, the common carotid artery (CCA) reference diameter should be >6 mm, and internal carotid artery diameter must be between 4 and 9 mm. CCA puncture site should be free of significant atherosclerotic disease.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

QUESTION 3

An anesthesia resident inquired about the advantages of TCAR over transfemoral carotid artery stenting (TFCAS). Which of the following statements is **FALSE**?

Please click on any of the following links to proceed to that question/topic.

A. [TCAR eliminates the need to cross the aortic arch](#)

B. [TCAR eliminates the need to insert distal embolic filter in the carotid artery](#)

C. [TCAR provides neuroprotection prior to engaging the lesion](#)

D. [TCAR eliminates the need for groin incision](#)

[Content Outline](#)

[Q1, Q2, Q4, Q5](#)

Sorry! Incorrect.

Click to Return to
Question

EXPLANATION

A. TCAR eliminates the need to cross the aortic arch

This statement is true.

During TCAR, direct carotid access has simplified carotid stent placement and obviated the need to traverse the aortic arch.

In TFCAS, a wire and catheter will be placed in the common femoral artery, and then navigated through a patient's aortic arch to cannulate the carotid artery. Patients with advanced atherosclerotic carotid disease are likely to have concomitant disease in the aortic arch, so the manipulation of a diseased aortic arch during TFCAS may lead to inadvertent plaque embolization to the brain.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

Ankam A, et al. Anesthetic Considerations for Transcarotid Artery Revascularization: Experience and Review of Forty Cases From a Single Medical Center. Cureus. 2020 Dec 24;12(12):e12250.

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Click to Return to
Question

EXPLANATION

B. TCAR eliminates the need to insert distal embolic filter in the carotid artery

This statement is true.

With flow reversal neuroprotection during TCAR, insertion of distal embolic filter inside the carotid artery is not needed.

During TFCAS, the adoption of distal embolic filter was able to mitigate some of the periprocedural stroke. However, the placement of these devices requires traversing the carotid lesion that may lead to iatrogenic stroke from carotid plaque. In addition, distal embolic filter may still allow the passage of small embolic particles through the filter pores and/or around the filter, especially if the filter is undersized or inadequately opposed to the arterial wall.

Lackey AR, et al. Transcarotid Artery Revascularization Results in Low Rates of Periprocedural Neurologic Events, Myocardial Infarction, and Death. Curr Cardiol Rep. 2020 Jan 15;22(1):3.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

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EXPLANATION

C. TCAR provides neuroprotection prior to engaging the lesion

This statement is true.

During TCAR, flow reversal initiates neuroprotection before crossing a carotid lesion and continues during balloon angioplasty and stent deployment. Evidences showed TCAR decreased the risk of periprocedural embolic stroke associated with TFCAS.

During TFCAS, the carotid lesion is crossed before deploying a distal embolic filter for neuroprotection. Therefore, the wire and catheter maneuvers used to cannulate the carotid artery and cross the carotid lesion are performed before a neuroprotection device in place, posing the risk of iatrogenic embolic stroke to a patient.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

Kumins NH, et al. Duration of blood flow reversal during transcarotid artery revascularization does not affect outcome. J Vasc Surg. 2020 Aug;72(2):584-588.

Great Job!! Correct.

Click to Return to
Question

[Next Question](#)

EXPLANATION

D. TCAR eliminates the need for groin incision

This statement is false.

During TCAR, the femoral vein is exposed and accessed percutaneously and a venous sheath is then placed. The distal end of the flow reversal system is then attached to this femoral venous sheath such that blood will flow from the high-pressure carotid artery to the low-pressure femoral vein during flow reversal.

Wang SK, et al. Anesthetic considerations in transcarotid artery revascularization. Semin Vasc Surg. 2020 Jun-Sep;33(1-2):10-15.

QUESTION 4

During the surgical huddle for TCAR, the goals for intraoperative management are reviewed together with the surgical team. Which of the following statements is **TRUE**?

Please click on any of the following links to proceed to that question/topic.

A. [A carotid shunt \(for antegrade flow\) may be inserted if cerebral hypoperfusion occurs](#)

B. [Bradycardia should be avoided during flow reversal](#)

C. [Flow reversal rate should be increased if cerebral hypoperfusion occurs](#)

D. [Blood pressure augmentation should be continued after a stent is deployed](#)

[Content Outline](#)

[Q1, Q2, Q3, Q5](#)

Sorry! Incorrect.

[Click to Return to Question](#)

EXPLANATION

A. A carotid shunt (for antegrade flow) may be inserted if cerebral hypoperfusion occurs

This statement is false.

While a carotid shunt insertion (for antegrade flow) in traditional CEA can be performed to mitigate cerebral hypoperfusion in approximately 10% of patients, the option to shunt is not available for TCAR (due to the nature of carotid flow reversal) should cerebral hypoperfusion be observed. As such, every effort should be made to minimize carotid clamping time and avoid hypotension during TCAR.

Wang SK, et al. Anesthetic considerations in transcarotid artery revascularization. Semin Vasc Surg. 2020 Jun-Sep;33(1-2):10-15.

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Question

EXPLANATION

B. Bradycardia should be avoided during flow reversal

This statement is true.

Carotid flow reversal is the critical phase of TCAR. It is of utmost importance to avoid hypotension and maintain heart rate about 70 bpm to maintain adequate cardiac output and effective reversed flow. Unless medically contraindicated (tachycardia at baseline, CAD, etc.), glycopyrrolate may be administered to maintain a heart rate of around 70 bpm during the carotid cross-clamp and flow reversal period, and prevent bradycardia/asystole associated with carotid sinus manipulation.

Ankam A, et al. Anesthetic Considerations for Transcarotid Artery Revascularization: Experience and Review of Forty Cases From a Single Medical Center. Cureus. 2020 Dec 24;12(12):e12250.

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EXPLANATION

C. Flow reversal rate should be increased if cerebral hypoperfusion occurs

This statement is false.

The reversed flow rate can be controlled by using the regulator with a setting for low or high flow. Operators can also temporarily arrest flow for angiographic imaging. During carotid flow reversal, if cerebral hypoperfusion is observed, BP elevation and toggling from high- to low-flow control on the flow reversal device (i.e., decrease flow reversal rate) are recommended. The procedure should be completed expeditiously, when possible. The option to unclamp carotid artery to allow for antegrade perfusion is also available.

Wang SK, et al. Anesthetic considerations in transcarotid artery revascularization. Semin Vasc Surg. 2020 Jun-Sep;33(1-2):10-15.

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Click to Return to
Question

Next Question 

EXPLANATION

D. Blood pressure augmentation should be continued after a stent is deployed

This statement is false.

The regional cerebral vessels have lost their ability to autoregulate due to the maximal vasodilation as a result of chronic ischemia. Cerebral hyperperfusion syndrome is thought to result from an abrupt increase in blood flow, after surgical reperfusion, in the chronically ischemic brain area where autoregulation is lost. A patient may experience headache, cerebral hemorrhage, brain edema, seizure and focal neurologic deficits.

After stent deployment, ipsilateral cerebral perfusion is significantly increased. BP goals should immediately shift to SBP 120-140 mmHg and profound hypertension should be avoided for the fear of cerebral hyperperfusion syndrome, myocardial ischemia and wound hematoma.

Farooq MU, et al. Pathophysiology and management of reperfusion injury and hyperperfusion syndrome after carotid endarterectomy and carotid artery stenting. Exp Transl Stroke Med. 2016 8(1):7.

Wang SK, et al. Anesthetic considerations in transcarotid artery revascularization. Semin Vasc Surg. 2020 Jun-Sep;33(1-2):10-15.

QUESTION 5

You informed the patient that, even with carotid flow reversal, there is still a risk of stroke during TCAR. Which of the following statements regarding the risk of stroke during TCAR is **FALSE**?

Please click on any of the following links to proceed to that question/topic.

[A. Embolic stroke may occur as a result of insufficient flow reversal](#)

[B. Cerebral hypoperfusion during flow reversal may lead to ischemic stroke](#)

[C. Embolic stroke may occur after resumption of carotid antegrade flow](#)

[D. The portion of surgical exposure of carotid artery is not associated with risk of stroke](#)

[Content Outline](#)

[Q1, Q2, Q3, Q4](#)

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[Click to Return to Question](#)

EXPLANATION

A. Embolic stroke may occur as a result of insufficient flow reversal

This statement is true.

If carotid flow reversal is insufficient, there is a risk of atherosclerotic plaque or thrombotic debris, that is not adequately flushed away from carotid artery and collected at the filter, entering the brain to cause embolic stroke.

Wang SK, et al. Anesthetic considerations in transcarotid artery revascularization. Semin Vasc Surg. 2020 Jun-Sep;33(1-2):10-15.

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EXPLANATION

B. Cerebral hypoperfusion during flow reversal may lead to ischemic stroke

This statement is true.

The primary limitation of TCAR's neuroprotective strategy is potential cerebral hypoperfusion during proximal carotid clamping and flow reversal. Cerebral hypoperfusion may occur as a result of hypotension, decreased antegrade perfusion and inadequate collateral flow from the circle of Willis during flow reversal, which may lead to ischemic stroke.

Olivere LA, et al. Cerebral monitoring during transcarotid artery revascularization with flow reversal via transcranial doppler ultrasound examination. J Vasc Surg. 2021 Jan;73(1):125-131.

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EXPLANATION

C. Embolic stroke may occur after resumption of carotid antegrade flow

This statement is true.

Intraoperative transcranial Doppler (TCD) monitoring of patients undergoing TCAR revealed that embolic events can occur during the re-initiation of antegrade flow in the internal carotid artery. This finding suggests that some particulate matters remain within the carotid artery during flow reversal, and the resumption of antegrade flow may result in emboli entering the ipsilateral hemisphere.

Olivere LA, et al. Cerebral monitoring during transcarotid artery revascularization with flow reversal via transcranial doppler ultrasound examination. J Vasc Surg. 2021 Jan;73(1):125-131.

Great Job!! Correct.

Click to Return to
Question

[The End](#) 

EXPLANATION

D. The portion of surgical exposure of carotid artery is not associated with risk of stroke

This statement is false.

If a patient is considered for TCAR procedure, the common carotid artery puncture site should be free of significant atherosclerotic disease. Otherwise, during surgical exposure of carotid artery, free atherosclerotic plaques or thrombotic debris may be generated and enter the brain to cause embolic stroke.

Liang P, et al. Transcarotid Artery Revascularization: Is It Better than Carotid Endarterectomy? Adv Surg. 2022 Sep;56(1):111-127.

Figure 1

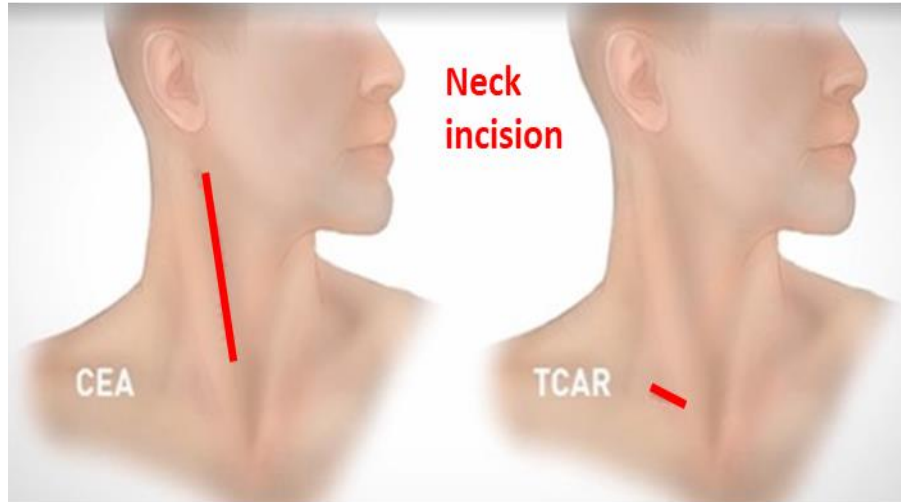
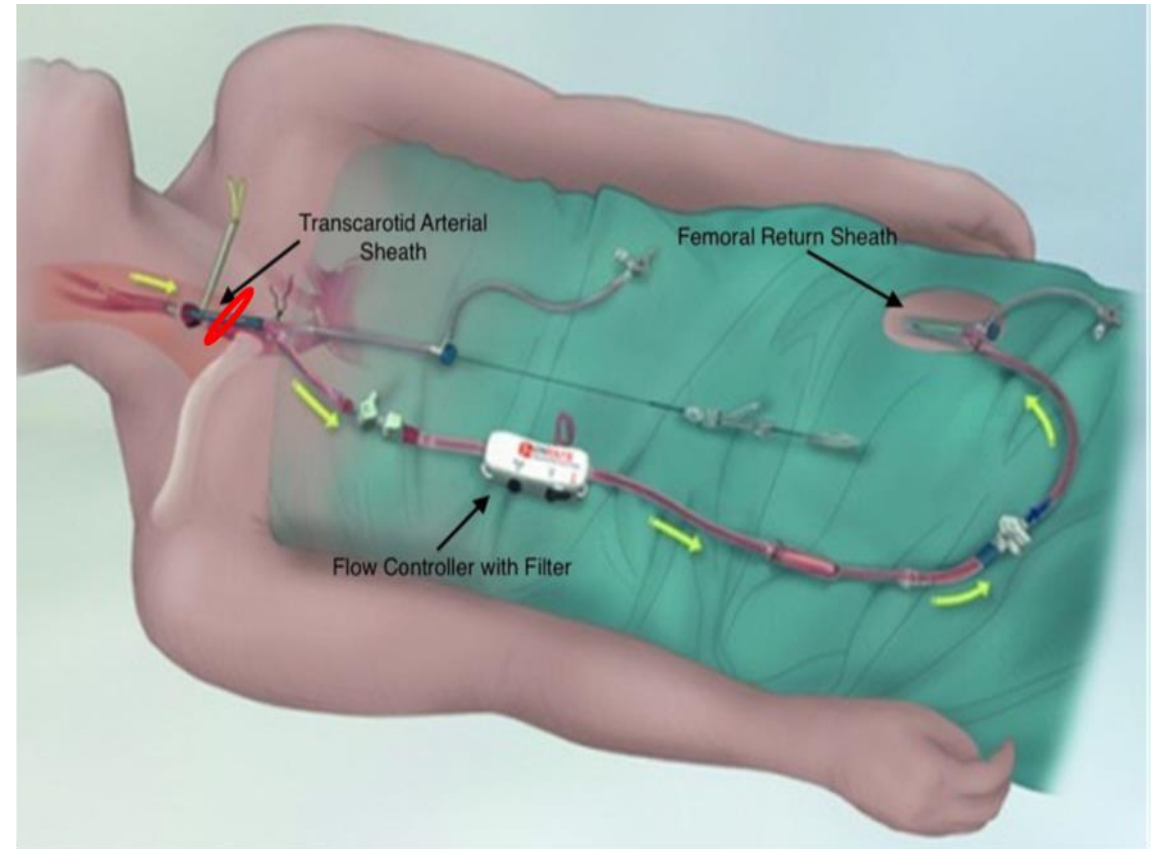


Figure 2



[Click to Return to Question](#)

Thank You!

Return to [Content Outline](#), [Q1](#), [Q2](#), [Q3](#), [Q4](#), [Q5](#)