COMBINED CAROTID ARTERY STENTING (CAS) AND CORONARY ARTERY BYPASS GRAFTING (CABG)

Essay

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Abstract

Perioperative stroke and ischemic encephalopathy are two well-recognized complications of coronary artery bypass grafting (CABG)

Surgical treatment of simultaneous coronary and carotid disease is still controversial

Carotid endarterectomy used to be considered as the gold standard treatment for carotid artery stenosis

Carotid artery stenting (CAS) is being investigated as an alternative treatment to carotid endarterectomy (CEA)

The safety of CAS has been particularly strengthened with the routine use of distal protection devices

There should be a protocol for use of antiplatelets drugs before and after CAS and after CABG

Keywords: Carotid artery stenting, coronary artery bypass grafting, carotid endarterectomy.

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List of Abbreviations	
ACAS	Asymptomatic Carotid Atherosclerosis study
ACT	Activated Clotting Time
AHA	American Heart Association
CABG	Coronary Artery Bypass Grafting
CAD	Coronary Artery Disease
CAS	Carotid Artery Stenting
CCA	Common Carotid Artery
CEA	Carotid Endaterectomy
CT	Computed Tomography
CVA	Cerebrovascular Accident
CASANOVA	Carotid Artery Stenosis with Asymptomatic Narrowing Operation Versus Aspirin
CRNA	Certified Registered Nurse Anaesthetist
ECA	External Carotid Artery
ECST	European Carotid Surgery Trial
FEV1	Forced Expiratory Volume in the 1^{st} second
ICA	Internal Carotid artery
HIV	Human Immuno Defeciency Virus
HDL	High Density Lipoprotein
LDL	Low Density Lipoprotein
MR	Magnetic Resonance
MRA	Magnetic Resonance Angiography
MPVR	Multiplaner Volume Rendering
MIP	Multiplaner Intensity Projection
MI	Myocardial Infarction
NASCET	North American Symptomatic Carotid Endarterectomy Trial
PTA	Percutaneous Transluminal Angioplasty
rtPA	Recombinant tissue Plasminogen Activator
TIA	Transient Ischemic Attacks
TCD	Trans Cranial Doppler
UCLA	University of California at Los Angeles

Introduction

Perioperative stroke and ischemic encephalopathy are two well-recognized complications of coronary artery bypass grafting (CABG). The risk of stroke in the perioperative period has remained $\underset{\sim}{}$ 2% for the past three decades. The presence of carotid disease in patients undergoing coronary artery bypass surgery has been shown to increase this risk of perioperative stroke from the cardiac procedure three folds. Trials of combined or staged carotid endarterectomy in these patients is an attempt to reduce perioperative mortality ***(Marc S. Randall et al., 2006).***

Surgical treatment of simultaneous coronary and carotid disease is still controversial, because of the high risk of morbidity and mortality after combined or staged carotid artery endarterectomy and the CABG approach ***(Luigi Chiariello et al., 2006).***

Certain forms of coronary artery disease, such as left main stem stenosis and the three vessels disease are better treated operatively than with percutaneous techniques. However, severe coronary artery disease and severe arterio-sclerotic disease of carotid artery commonly coincide ***(J. Waigand et al., 1998).***

Carotid endarterectomy used to be considered as the gold standard treatment for carotid artery stenosis. However this approach is not free of complications ***(G. Stankovic et al., 2002).***

Carotid artery stenting (CAS) is being investigated as an alternative treatment to carotid endarterectomy (CEA). The goal of both procedures is the prevention of stroke from extra cranial carotid artery occlusive disease. Carotid stenting, compared with surgery, offers patients a less invasive and traumatic means of achieving this goal. The efficacy of carotid stenting in preventing stroke depends on the ability of the operator to achieve complication-free results ***(Jiri J. Vitek et al., 2000)***.

Use of carotid artery stenting (CAS), as on alternative to CEA before or with cardiac surgery, has been proposed as a less risky carotid revascularization strategy ***(Kovacic JC et al., 2004).***

The safety of CAS has been particularly strengthened with the routine use of distal protection and the use of these devices should be considered the standard of care ***(Yadav JS. Et al., 2004)***.

Anatomy

The Common Carotid Arteries:

The left common carotid artery arises from the aortic arch in front and to the right of the origin of the left subclavian artery. It passes behind the left sternoclavicular joint, lying in its thoracic course at first in front and then to the left side of the trachea, with the left lung and pleura, the vagus and the phrenic nerve as its lateral relations ***(Harold Ellis .,2002)***.

The right common carotid artery begins behind the right sternoclavicular joint at the bifurcation of the brachiocephalic artery ***(Harold Ellis .,2002)***.

In the neck, both common carotids have essentially similar courses and relationships; they ascend in the carotid facial sheath which contains also the internal jugular vein laterally, and the vagus nerve between and rather behind the artery and vein. The cervical sympathetic chain ascends immediately posterior to the carotid sheath. These structures form a quartet which should always be considered in this inseparable manner; the relations of any one are those of the other three ***(Harold Ellis .,2002)***.

In the neck, each common carotid artery lies on the cervical transverse processes, separated from them by the prevertebral muscles. Medially are the larynx and trachea, with the recurrent laryngeal nerve, pharynx and oesophagus, together with the thyroid gland, which overlaps on the anterior aspect of the carotid. Superficially, the artery is covered by the sternocleidomastoid and, in its lower part, by the strap muscles and is crossed by the intermediate tendon of omohyoid ***(Harold Ellis .,2002)***.

The common carotid artery gives off no side branches but terminates at the level of the upper border of the thyroid cartilage (at the vertebral level C4) into the external and internal carotids, which are more or less equal in size.

The common carotid arteries ascend in the neck, running anterior to the transverse processes of the cervical vertebrae and separated from them by the anterior scalene, longus coli and capitis muscles and by the sympathetic trunks***(Sinnatamby .,1999)***.

The carotid arteries bifurcate at the same level in only 28% of cases; in 50%, the left bifurcation is higher than the right one, whereas the reverse is present in the remaining 22% ***(Sinnatamby .,1999)***.

The External Carotid Artery:

This artery lies first deep to the anterior border of the sternocleidomastoid and then quite superficially in the anterior triangle of the neck, where its pulsations are usually visible as well as palpable. At first it is slightly deep to the internal carotid, then passes anterior and lateral to it. The internal jugular vein is first lateral to the external carotid then posterior to it, coming into lateral relationship to the internal carotid. The pharynx lies medially ***(Robert B. Rutherford .,2005)***.

The external carotid artery ascends beneath the hypoglossal nerve and the posterior belly of the digastric to enter the parotid gland, within which it lies deep to the facial nerve and the retromandibular vein ***(Robert B. Rutherford .,2005)***.

The artery ends within the parotid gland at the level of the neck of the mandible by dividing into the superficial temporal and internal maxillary arteries.

Branches:

1. The superior thyroid artery (giving off the superior laryngeal artery).
2. The lingual artery, passing deep to the hyoglossus to supply the tongue.
3. The facial artery, which gives off its important branch to the palatine tonsil, loops over the submandibular gland, hooks round the mandible (against which it can be felt pulsating), and ascends on to the face.

4. The occipital artery, running along the inferior border of the digastric muscle's posterior belly, grooving the inferior aspect of the temporal bone, to the back of the scalp, where its pulse is often palpable.
5. The posterior auricular artery, which supplies the skin of the back of the ear and behind the ear.
6. The ascending pharyngeal artery, the smallest branch, ascends between the internal carotid and the pharynx, which it helps supply.

Its terminal branches are:

* The superficial temporal artery, which is palpable on the zygomatic process;
* The maxillary artery, which supplies the upper and lower jaws, nasal cavity and the muscles of mastication, accompanying the various branches of the maxillary division of the trigeminal nerve, and also gives off the middle meningeal artery. This small vessel ascends through the foramen spinosum and helps to supply the meninges. Its practical importance is that it may be torn in a skull fracture and result in the formation of an extradural haematoma.

The external carotid artery is usually smaller than the internal carotid artery.

These vessels are of significance to the cerebral circulation in the setting of carotid or vertebral artery occlusive disease, where they can become important sources of collateral blood supply ***(Harold Ellis .,2002)***.

One of the most common collateral routes involves distal anastomoses between the pterygopalatine branches of the internal maxillary artery and the ethmoidal branches of the ophthalmic artery system. Other important collateral pathways include anastomoses between orbitonasal branches of the facial artery and orbital branches of the ophthalmic artery, anastomoses between anterior branches of the superficial temporal artery and ethmoidal branches of the ophthalmic artery, and anastomoses between ascending pharyngeal branches of the external carotid artery and muscular branches of the vertebral artery ***(Sinnatamby .,1999)***.

The Internal Carotid Artery and Circle of Willis:

This artery commences at the bifurcation of the common carotid, and, at its origin, is dilated into the carotid sinus. This area receives a rich nerve supply from glossopharyngeal nerve and acts as a pressor-receptor; through this mechanism a rise of blood pressure brings about reflex slowing of the heart and peripheral vasodilatation. Tucked deep to the bifurcation is the small, yellowish carotid body which is also supplied by glossopharyngeal nerve. This is a chemoreceptor which produces a reflex increase in respiration response to any rise in CO2 tension or fall in the oxygen tension of the blood ***(Sinnatamby .,1999)***.

The internal carotid lies first lateral to the external carotid but rapidly passes medial and posterior to it, to ascend along the side-wall of the pharynx. It does so with the internal jugular vein, vagus and cervical sympatheticchain in the same relationship to it that they bear to the common carotid artery. At first the artery is covered superficially only by the sternocleidomastoid, hypoglossal nerve, and the common facial vein; it then passes under the posterior belly of the digastric muscle and parotid gland to the base of the skull. It is separated from the external carotid artery not only by the parotid but also by the styloid process and the muscles arising from it, by glossopharyngealnerve and by the pharyngeal branches of vagus nerve ***(Harold Ellis .,2002)***.

At the base of the skull, the internal carotid artery enters the carotid canal in the petrous temporal bone. Only at the skull base does the internal jugular vein lose its close lateral relation to the internal carotid, passing posterior to the artery into the jugular foramen. At this point the two vessels are separated by the emerging last four cranial nerves. The artery gives off no branches in the neck ***(Harold Ellis .,2002)***.

The internal carotid, on entering the skull, commences an extraordinary twisted course. It passes forwards through the temporal bone, upwards into the cavernous sinus, forward in this, upwards through the roof of the sinus to lie medial to the anterior clinoid process, turns back on itself above the cavernous sinus, then passes up once more, lateral to the optic chiasma, to end by dividing into the anterior and middle cerebral arteries. There are thus six bends in the intracranial course of this artery which are believed to lessen the pulsating force of the arterial systolic blood pressure on the delicate cerebral tissues ***(Harold Ellis .,2002)***.

The ophthalmic artery originates from the internal carotid immediately after its emergence from the cavernous sinus, enters the orbit through the optic foramen below and lateral to the optic nerve and supplies the orbital contents and the skin above the eyebrow (via the supratrochlear and supra-orbital branches). Its most important branch, however, is the central artery of the retina which is the sole blood supply to this structure ***(Robert B. Rutherford .,2005)***.

The two terminal branches of the internal carotid are distributed as follows:

- The anterior cerebral artery winds round the genu of the corpus callosum to supply the medial and superolateral aspect of the cerebral hemisphere.
- The middle cerebral artery enters the lateral cerebral sulcus, gives off central branches to supply the internal capsule ('the artery of cerebral haemorrhage') and feeds most of the lateral aspect of the cerebral cortex ***(Robert B. Rutherford .,2005)***.

The internal carotid artery is divided into five major segments: carotid bulb, cervical, petrous, cavernous, and cerebral.

The petrous segment also has no major branches, although there are minor branches that anastomose with small pterygopalatine branches of the internal maxillary artery that can become sources of collateral supply in the setting of occlusive disease ***(Sinnatamby .,1999)***.