

Role of multislice C.T. angiography in diagnosis of cerebral aneurysm

Essay

Submitted for partial fulfillment of
master degree in radiodiagnosis

Presented by

Susan Adil Ali Abdul Rahim
M.B.B.CH.
Ain Shams University

Supervised by

Prof. Dr. Saad Ali Abd Rabou
Professor of radiodiagnosis
Faculty of Medicine
Ain Shams University

Dr. Naglaa Hussein Shebrya
Assistant Professor of radiodiagnosis
Faculty of Medicine
Ain Shams University

Department of radiodiagnosis
Faculty of Medicine
Ain Shams University

٢٠٠٨

بسم الله الرحمن الرحيم

قالوا سبحانك لا علم لنا الا ما علمتنا انك انت العليم
الحكيم

صدق الله العظيم

Acknowledgment

First, thanks are all due to God for blessing this work until it has reached its end as a part of his generous help throughout my life.

I wish to express my thanks and profound gratitude to Professor Dr. Saad Ali Abd Rabou, professor of radio diagnosis, Ain Shams University. Who I am deeply indebted for encouraging me to develop this work, and for the valuable supervision and continuous help he has given me since I started this work.

Also, I am deeply indebted to Assistant Professor Dr. Naglaa Hussein Shebrya, Assistant professor of radio diagnosis, Ain Shams University, for her valuable instructions, inspiring guidance and support throughout this work.

Finally, I would like to express my deepest gratitude to all my family, who has all supported me during my work.

CONTENTS

INTRODUCTION AND AIM OF THE WORK	١
ANATOMY OF CEREBRAL ARTERIES	٢
PATHOLOGY OF CEREBRAL ANEURYSMS	٢٢
TECHNIQUE OF MSCTA	٤٢
MSCTA MANIFESTATIONS OF CEREBRAL ANEURYSMS	٦٧
ILLUSTRATIVE CASES	٨٥
SUMMARY AND CONCLUSION	٩٥
REFERENCES	٩٨
ARABIC SUMMARY	١١٢

List of tables

Table number	Subject	Page
Table ۲-۱	Hunt and Hess classification	۳۲
Table ۳-۱	Advantages of MDCT	۴۵

List of figures

Figure number	Subject	Page
Figure ١-١	The internal carotid and vertebral arteries.	٢
Figure ١-٢	Lateral anatomical diagram depicting the seven ICA segments.	٤
Figure ١-٣	Diagram illustrating the petrous (C٢) ICA as well as its branches and adjacent structures.	٦
Figure ١-٤	Branches of the anterior cerebral artery	١١
Figure ١-٥	Branches of middle cerebral artery	١٣
Figure ١-٦	The Vertebrobasilar system	١٦
Figure ١-٧a	base of the brain showing Circle of Willis	١٩
Figure ١-٧b	diagram showing Circle of Willis	٢٠
Figure ١-٨	MDCTA images of cerebral arteries	٢١
Figure ٢-١	A section across the wall of a brain artery	٢٣
Figure ٢-٢	Sequence of Brain Aneurysm Formation	٢٥
Figure ٢-٣	Common locations of intracranial aneurysms, with approximate incidences.	٢٩
Figure ٢-٤	Sequence of aneurysm rupture	٣٣
Figure ٢-٥	Cerebral vasospasm	٣٤
Figure ٣-١	MSCT scanner	٤٣
Figure ٣-٢	Analysis of CT angiography data with MPR and thin-section MIP	٥٩
Figure ٣-٣	Threshold-dependent ٣D visualization with SSD	٦٠
Figure ٣-٤	Visualization of the intracranial arteries with ٣D dVR performed by using different colors.	٦٢
Figure ٣-٥	Influence of ٣D visualization techniques on the detection of intracranial aneurysms.	٦٢

Figure ۳-۶	Standard ۳D projections obtained by using dVR interactively on the workstation (left) and diagrams of the corresponding arterial anatomy	۶۳
Figure ۳-۷	Different possibilities for examining an aneurysm of the left MCA with dVR.	۶۴

Figure ۴-۱	Aneurysm of the basilar artery	۷۰
Figure ۴-۲	Infundibular dilatation at the origin of the right PICA.	۷۳
Figure ۴-۳	Aneurysm of the left infraclinoidal ICA	۷۴
Figure ۴-۴	Different qualities of bone removal	۷۵
Figure ۴-۵	MIP images of an ROI of ۲۵۶ x ۲۵۶ pixels . A and B, Without bone elimination. C and D, With matched subtraction. E and F, With MMBE.	۷۶
Figure ۴-۶	۳D visualization of intracranial arteries from a posterosuperior view parallel to the clivus.	۷۸
Figure ۴-۷	Use of CT angiography for planning surgical therapy in a patient with two small aneurysms at the bifurcation of the right MCA	۸۰
Figure ۴-۸	Use of CT angiography for planning and follow up of endovascular therapy.	۸۲
Figure ۴-۹	Images of illustrative case no. (۱)	۸۵
Figure ۴-۱۰	Images of illustrative case no. (۲)	۸۶
Figure ۴-۱۱	Images of illustrative case no. (۳)	۸۷
Figure ۴-۱۲	Images of illustrative case no. (۴)	۸۸
Figure ۴-۱۳	Images of illustrative case no. (۵)	۸۹
Figure ۴-۱۴	Images of illustrative case no. (۶)	۹۰
Figure ۴-۱۵	Images of illustrative case no. (۷)	۹۱
Figure ۴-۱۶	Images of illustrative case no. (۸)	۹۲
Figure ۴-۱۷	Images of illustrative case no. (۹)	۹۳
Figure ۴-۱۸	Images of illustrative case no. (۱۰)	۹۴

List of abbreviations

ACA	Anterior cerebral artery
ACoA	Anterior communicating artery
AICA	Anterior inferior cerebellar artery
cm	Centimeter
CM	Contrast medium
CT	Computed Tomography
DSA	Digital subtraction angiography
dVR	Direct volume rendering
EVT	Endovascular treatment
FMD	Fibromuscular dysplasia
ICA	Internal carotid artery
Kv	Kilovolt
mA	Milliamper
MCA	Middle cerebral artery
MIP	Maximum intensity projection
ml	Milliliter
mm	Millimeter
MDCT	Multidetector computed tomography
MPR	Multiplanar reformation
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
MSCT	Multislice computed tomography
PCA	Posterior cerebral artery
PCoA	Posterior communicating artery
PICA	Posterior inferior cerebellar artery
SAH	Subarachnoid hemorrhage
SSD	Shaded surface display
TOF	Time of flight
VA	Vertebral artery

Introduction and Aim of the work

Intracranial aneurysms are relatively common with a prevalence of approximately 4%. (**Keedy., 2007**). Most aneurysms are asymptomatic, however, one of the most frequent causes of subarachnoid haemorrhage is ruptured aneurysms. (**Rinkel., 2007**). Ruptured aneurysms not only cause subarachnoid haemorrhage but can also cause subdural or intracranial haematomas. (**Ohkuma et al., 2007**).

There are currently three imaging modalities widely used in the diagnosis of intracranial aneurysms : intra-arterial digital subtraction angiography (IADSA), computed tomography angiography (CTA) and magnetic resonance angiography (MRA). (**Keedy., 2007**).

The development of multidetector CT (MDCT) scanners has been one of the most important technological advances of CT technology. (**Duddalwar., 2004**). Multidetector CT scanners are fundamentally improved over single detector CT scanners in many ways: faster acquisition speeds, higher spatial resolution, and better image quality, new clinical applications, greater diagnostic accuracy, more efficient workflow, increased productivity, and better quality. (**Katherine., 2004**)

The aim of this work is to evaluate the role of multidetector CT angiography in diagnosis of cerebral aneurysm .

Anatomy of the cerebral arteries

The arterial supply of the brain is derived from the Internal Carotid artery (ICA) and Vertebral artery (VA) , which lie together with their proximal branches within the subarachnoid space at the base of the brain (figure ١-١). (*Standring et al,*

٢

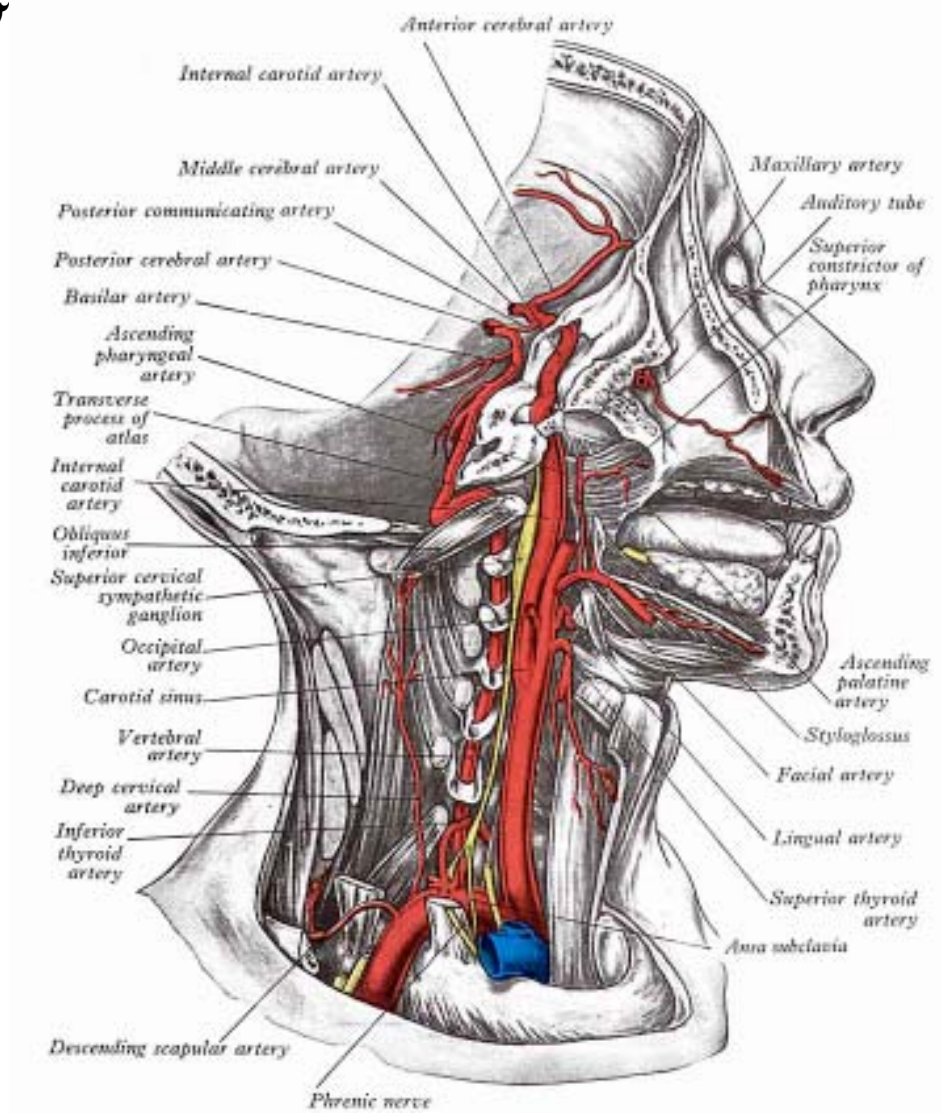


Figure (١-١) The internal carotid and vertebral arteries

. (Quoted from Standring et al, ۲۰۰۹).

A- Internal Carotid System (Internal Carotid Artery):

The Internal Carotid Arteries (ICAs) and their branches (sometimes referred to as the Internal Carotid System) essentially supply blood to the forebrain, with the exception of the occipital lobe. (*Standring et al, ٢٠٠٩*)

The ICA arises from the bifurcation of the Common Carotid artery, it ascends along the neck and enters the carotid canal of the temporal bone. (*Standring et al, ٢٠٠٩*).

The ICA can be divided into seven segments according to their adjacent anatomical structures & the compartments they traverse, including: C^١ or cervical portion – C^٢ or petrous portion – C^٣ or Lacerum portion – C^٤ or cavernous portion – C^٥ or clinoidal portion – C^٦ or ophthalmic portion & C^٧ or communicating portion (figure ١-٢). (*Osborn, ١٩٩٩*)

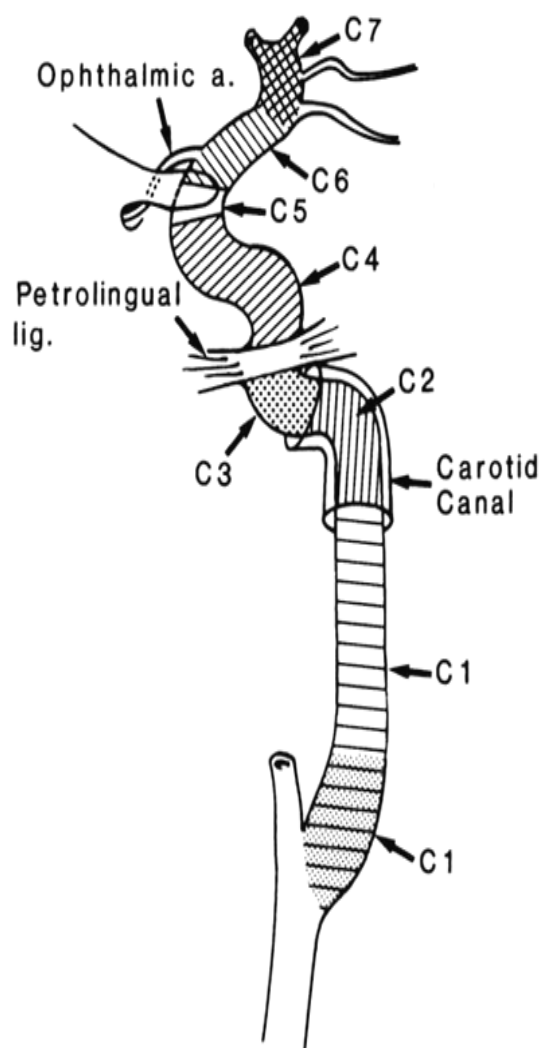


Figure (١-٢): Lateral anatomical diagram depicting the seven ICA segments. C^١ = cervical segment (the bulb is indicated by *stippling*, and the ascending segment by *horizontal lines*); C^٢ = petrous segment; C^٣ = lacerum segment; C^٤ = cavernous segment; C^٥ = clinoidal segment; C^٦ = ophthalmic segment; C^٧ = communicating segment. a. = artery; lig. = ligament

figure (١-٢) Segments of ICA
(Quoted from Osborn, ١٩٩٩)

1- Cervical portion (C 1)

The internal carotid artery continues superiorly from its origin to the base of the skull . it has localized dilatation at its origin called carotid sinus . it has no branches. (**Ryan et al, ٢٠٠٤**)

٢- Petrous & Lacerum portions (C ٢ & C ٣)

These parts of the ICA ascend in the Carotid canal & curves anteromedially & then superomedially above the cartilage filling the foramen lacerum to enter the cranial cavity. (**Standring et al, ٢٠٠٩**)

The lacerum portion represents the portion extending from petrous endocranial carotid canal to the petrolingual ligament. (**Osborn, ١٩٩٩**)

• Branches:

- The petrous ICA (C٢) gives off two small branches – the Vidian & Caroticotympanic arteries – which are small and inconsistent but may provide a collateral blood flow from the External Carotid artery if the ICA occlusion is present. (figure ١-٣).

- The lacerum portion gives no branches. (**Osborn, 1999**)

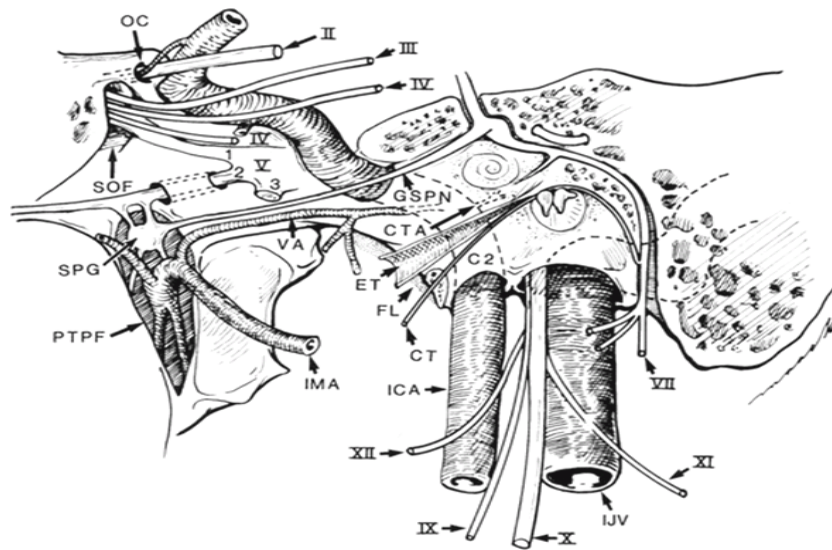


Figure (1-3) Diagram illustrating the petrous (C₂) ICA as well as its branches and adjacent structures. Note that the petrous ICA has an ascending vertical segment, a posterolateral genu, and a longer horizontal segment. The posterior genu in the intrapetrous ICA lies just in front of and below the cochlea. The two significant petrous ICA branches are the caroticotympanic artery (CTA) and the vidian artery (VA). The lacerum (C₃) ICA segment is a short segment that extends from the endocranial opening of the carotid canal to the petrolingual ligament. It typically lies just above the foramen lacerum (FL, indicated by *stippling*), which in living patients is filled with fibrocartilage. Cranial nerves are indicated by Roman numerals, and carotid segments are indicated by Arabic numbers. CT = chorda tympani; GSPN = greater superficial petrosal nerve; IMA = internal maxillary artery (ECA branch); OC = optical canal; PTPF = pterygopalatine fossa; SOF = superior orbital fissure; SPG = sphenopalatine ganglion.