ROLE OF DIGITAL VASCULAR IMAGING IN DIAGNOSIS OF RENAL ARTERY DISEASES

THESIS

Submitted in partial fulfilment for the Master degree of radiodiagnosis

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1988

ACKNOWLEDGEMENT

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I wish to express my deep thanks and gratitude to prof. Dr. ABDEL ZAHER ALY HASSAN , who been like a GOD father to me and to prof. Dr. MEDHAT GALEB , for pushing me in the first step to start my career ; and to all my colleagues who keep pushing me foreward by their kind words .

To them all , I'm owned by their endless effort in helping me to present this work to you .

بسم الله الرحمن الرحيم

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KEY TO ABBREVIATIONS

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- A.D.C.-.......Analouge digital convertor .
- A.P.R.-....... Anatomical programed radiography .
- D.S.A.-.......Digital subtraction angiography .
- D.V.P.-....... Digital video processing .
- I.A.-......... Intra-arterial .
- I.V.-......... Intra-venous .
- Kvp.-......... Exposure voltage .
- mR. -......... Mill. Roentgen .
- mA. -......... Mill. ampear .
- S.V.C.-....... Superior vena cava .
- uR. -......... Micro Roentgen .

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INTRODUCTION

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INTRODUCTION AND AIM OF WORK

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Digital subtraction angiography (D.S.A.) is an exa-
-amination method that was first applied in clinical pra-
-ctice in 1980 .

Based on digital image processing with subtraction
and contrast enhancement . It clears the way for imaging
blood vessels by means of intra-venous injection of con-
-trast medium .

In this way a simplified angiographic technique bec-
-ame avilable in which risks associated with angiography
were reduced .

So the aim of this work is to give a brief idea abo-
-ut the subsistence and the ability of this new era in
the diagnosis of renal artery diseases .

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REVIEW OF LITERATURE

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HISTORICAL BACKGROUND OF D.V.I.

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The immense current interest in vascular imaging is not a new phenomenon ; it was no more than one month after Rontgen reported on his discovery of the X-ray in 1895 , (Rontgen 1895) , when Haschek and Lindenthal inj--ected opaque material into the vessels of an amputated hand . Since then tremendous progress has occured invol--ving all aspects of angiography , from X-ray equipment in general , rapid changers , and injectors to refinem--ents of the chemical structure of contrast media . With regard to catheterization and contrast delivery methods, few changeshad occured since the early 1920 , when the first angiogrames were reported in man .(Berberich 1923)

By the mid 1930's , direct arteriography of the peripheral and carotid arteries and of the aorta by tra--nslumbar approach were performed .(Saddekni 1983)

Angiography based on the technique described by " Forsmann ", who introduced a catheter into his own ri--ght atrium (Forsmann 1931) was reported .However , the left side of the heart and thoracic aorta were still pr--actically beyond reach untill intravenous angiography was introduced by ROBB and STEINBERG in 1938 .(Robb 1938)

Originally the method consisted of basilic vein cat--heterization with a 12-gauge cannula and rapid injection of 25-45 ml. of concentrated diodrast (70 %) with the patient in a sitting or standing position . The expoures were made in an interval based on measurement of the arm to pulmonary or arm to carotid circulation times .

This method remained in use well into the 1950 , and the indications were expanded to include intra-venous aor--tography and peripheral and carotid angiography .(Stein--berg 1959)

For these indications , it became necessary to cann--ulate both arms and deliver up to 100 ml. of contrast medium per injection in order to improve visualization .. However , simplification of arterial catheterization in the early 1950 by ' SELDINGER ' allowed direct arteriog--raphy to replace intra-venous angiography .(Seldinger - - 1953)

Interest in intravenous angiography was renewed in the late 1970 owing to the advent of computer technology, which made use of electronic enhancement and processing techniques . (Manelfe 1982)

Combined with another technique , subtraction , which had been described even before intravenous angiography by Ziedses des Plantes (Ziedses des Plantes 1935) and which had been used largely in Europe , the possibility of less invasive arterial depiction by intra-venous injection bec--ame feasible . (Marcel 1985)

D.S.A. TECHNOLOGY AND EQUIPMENT

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The equipment used in digital subtraction angiogra--phy is a combination of X-ray equipment and high speed image processing equipment . The X-ray equipment consists a state of the art X-ray generator and a large field image intesifier coupled to a television camera . The signal from the television camera is digitized and fed into an image processor . Raw images are stored in the processor during the acquisation phase , processed , and then immediatly displayed at the termination of the angi--graphic examination . (Theron W.Ovitt 1985)

To get the best results from intra-venous digital subtraction angiography , both the doctor and the equip--ment must fulfil certain conditions :

(1) The doctor must be fully acquanted with the radiogra--phic anatomy of the vascular structures , the physiology of the circulation and the technical requirements of the examination procedure .

(2) The equipment must provide adequate coverage of the area under examination with good resolution and contrast discrimination and in a simple convenient operation .

(3) Automatic exposure control in the digital system ,the optimum exposures parameters are determined by automatic test shots at very low exposure levels , made during the preparation for each series .(Ludwig J.W. 1982)

TECHNICAL DESCRIPTION :

(1) Image Intensifier :

An image intensifier is the X-ray detector in a D.S.A. image recording system . It has an input screen of 14 in. diameter , switchable to 10 in. and 6 in. filds .(Oosterkamp 1974)

It is very desirable to have a large field image intensifier , 14 to 16 inches in diameter , so that a patient's entir chest , abdomen , or both lower extremities can be accomodated on one field . The larger image intensifier will decrease the spatial resolution of the final image , because the 512 x 512 matrix is now encompassing a larger image input area . This can be compensated for by incorporating a 1024 x 1024 line acquisation system .
(Barbaric 1982)

For accurate diagnosis , it is important to be able to cover an entire organ system so that all arteries can be followed to their termination . (W.Ovitt 1985)

Alarge image is also important because it decreases the number of contrast injections needed to evaluate an iliac or femoral arterial system . It is very important that the image intensifier be mounted on a C-arm or L-arm or similar apparatus so that the pateint remains in the supine position . In D.S.A. , multiple angulated views are necessary for most examinations . The artifacts due to patient motion are greatly reduced when the intensifier tube system is rotated rather than the patient . To obtain a motionless examination , it is extremely important for the patient to be relaxed and in a supine position . (John D. 1985)

(2) T.V. Chain (Television System)

There is a variable aperture iris interposed between the output of the image intensifier and the input of the television camera . This iris is set so that the amount of light produced by a 1-millrontegen exposure to the inte-ensifier complitely fills the dynamic range of the teli-vision system . Most available D.S.A. equipment will operate using a 512 x 512 image matrix . The next step is to use an A-D convertor (analoge-to-digital) to digitize the video output from the television system and the subs-equent output of the A-D convertor is inputted into the image processor . (Ovitt 1985)

(3) X-ray Tube :

The requirements for the X-ray tube are similar to those for general angiography . A high heat capacity tube is necessary so that multiple high-intensity exposure can be made . The usual sequence in an intravenous D.S.A. pro-cedure is to perform one or two exposures per second over 10 to 15 second interval after the injection of contrast material . This produces a rather high heat load for an ordinary X-ray tube , but it is readily tolerated by an X-ray tube with 400,000 to 800,000 anode heat storage unit available.

Special X-ray tube collimation and X-ray beam filtra-tion are required in D.S.A. systems , because of the limited dynamic range of the television camera and the necessity of having a uniform X-ray beam exposure to the image intensifier . The preferred X-ray beam filtration is