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CT SCAN PROCEDURE FOR THE STUDY OF ARTERY ISCHEMIA

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Abstract: The main objective of this article is to show the importance of Computed Tomography (CT) in performing an abdominal examination for mesenteric artery ischemia, making it necessary to explore some of the anatomy and physiology of the lymphatic system itself in order to understand it. A 73-year-old male patient, weighing 70 kg, admitted to the emergency department with diffuse abdominal pain, with a confirmed diagnosis of mesenteric artery ischemia. I mention the effect of ionizing radiation for the necessary functioning of the tomograph and the risk-benefit it exerts on the patient to ionizing radiation for diagnosis and radiological protection in Standard NN 3.01 of the National Nuclear Energy Commission (CNEN). As far as the physical procedure of the device is concerned, it is necessary to mention how the positioning works, the acquisition time, the contrast injection phases by programming the injection pump. With regard to the software, through image reconstruction, collimation in windows for framing the structures to be studied, where the program has the possibility of performing 3D reconstructions for a better diagnosis, not forgetting the powerful DICOM and RPACS system in cloud allocation, saving and sending the exams to be connected.

Keywords: Mesenteric artery ischemia; computed tomography; window; venous contrast; injection pump;

INTRODUCTION

Since the beginning of humanity, we have brought with us in our genetic forms the different forms of diseases acquired over time, so there was a need to know and analyze these factors. However, the importance of treatments became imminent, and the names came for ease, communications, interpretations, and the international union in the technical terms to be known, because in this case the

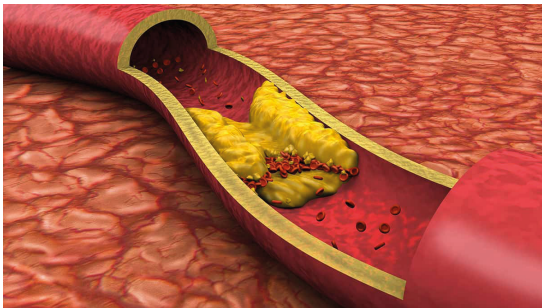
term Pathology derived from the Greek Pathos (disease) and Logos (study), thus, the various ways of understanding treatments were molded and perfected, from a simple fracture, to the most complex exams in the search for a safe diagnosis with the purpose of treating the patient. The word physiology, which also comes from the Greek Physis (nature) and logos as we have already read, means (study), and this physical and chemical process of energy in the human body is only possible with the transportation of blood to the entire body through pipes, we call the circulatory system made up of complex networks of veins, arteries, capillaries and the heart itself for the distribution of blood flow. However, it must be understood that the veins drain the blood of carbon dioxide (CO₂) and its impurities, while the arteries leave the heart, carry the blood rich in oxygen (O₂) and its nutrients, pass through the capillaries carrying out the gas exchange, returning to the heart through the vena cava, carrying out this cycle.

When there is a reduction or interruption of blood flow in an arterial channel in a certain part of the body, we call it ischemia. This is because some atheromatous plaques deposited on the walls of the artery with accumulations of fat inhibit the passage of nutrients and can be located in various parts of the body such as the brain, legs, arms, eyes, intestines, etc. As a result, a certain structure that needs that O₂ will be compromised and the organ's functionality may be affected. However, if the ischemia is removed by a medical procedure, the structures can return to normal.

Acute pains - these are recent pains, lasting only a short time, it doesn't depend on the intensity of the pain, the process is quicker.

Chronic pain - is pain that persists over time. It also doesn't depend on the intensity of the pain, the process is longer.

Acute Mesenteric Artery Ischemia (AMIA) is a disease of the superior mesenteric artery with the presence of thrombosis (caused by arteriosclerosis) or embolism (with the main source being the heart). In this case, a patient with disproportionate abdominal pain and great intensity, afraid to eat, knowing more about the clinical picture, will see that it is acute pain in a patient who already has chronic pain, with weight loss. This information needs to be gathered in order to suspend the acute mesenteric ischemia.

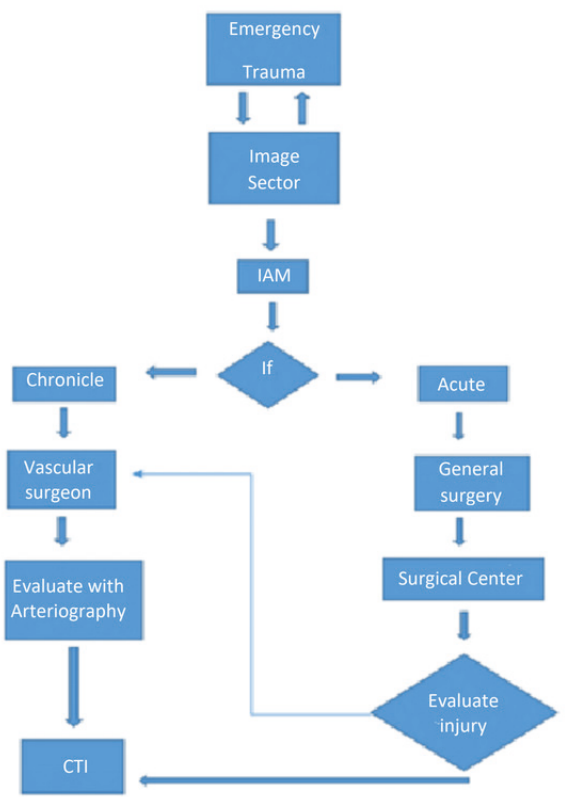


Representation of ischemia

The abdomen has several branches of vessels, all aligned in an organic and physiological way, properly supplying blood to the small and large intestines, the pancreas and the other viscera, evolving the organs in their magnitude, since the focus of this study is on the flow of the mesenteric arteries:

The superior mesenteric artery (SMA), the largest artery of the abdominal viscera, originates in the anterior part of the aorta and is located 1 cm below the celiac trunk, posterior to the body of the pancreas and the splenic vein, at the level of the intervertebral discs between L1 and L2, then entering the mesentery (SILVA, 2020).

The inferior mesenteric artery (IMA) has a smaller diameter compared to the superior mesenteric, originating between the L3 and L4 vertebrae, as current data indicates that the inferior mesenteric artery generally irrigates the left third of the transverse colon, descending colon, sigmoid colon and rectum (COVANȚEV, 2017).



Flowchart of emergency steps

Nowadays, Computed Tomography (CT) has made significant progress in diagnostic imaging, as the device’s technology will give patterns in shades of gray and shades of white for each tissue with greater or lesser density, thus establishing the Hounsfield scale, where the quantitative measure that describes tissue radiodensity, through the opening of windows, with distinctions of different tissues, is of great diagnostic importance. This scale goes from minus 1000 to plus 1000 according to the gray and white tones of the image.

Density on CT	Attenuation values	Image in the movie
Contrast medium	+100 a 1.000	Bright white
Bone	100	White
Water (soft parts)	0 a 100	Medium gray
Fat	-60 a -100	Dark gray
Air	-120 a -1.000	Black

Hounsfield Scale - thenegatoscope, 2024

METHOD

The focus of this work was on the Albert Schweitzer Municipal Hospital (HMAS), which is made up of the Regional Emergency Coordination (CER), in imaging services made up of reference hospitals in urgent and emergency care for the population of the West Zone of Rio de Janeiro, with a 32-channel Siemens Healthineers SOMATOM go.Up helical CT scanner.



CT scanner used for the study

The purpose of this article is to report on the importance of the work of a multidisciplinary team a male patient was admitted with diffuse abdominal pain and severe abdominal distension. On January 6th, patient "X", 73 years old, weighing 70 kilos, with high blood pressure, was admitted to the emergency department, assigned to the trauma department, assessed and referred to the imaging department to undergo Computed Tomography Angiography (CTA).

Receiving the patient for the examination, accompanied by the nursing team, for the study in the abdominal region, according to the protocol, with the patient in the apparatus and already positioned, it was necessary to open a Field of View (FOV), which is the image obtained on the technician's monitor that scanned the structure, with an extension of the cut above the diaphragmatic domes to the pubic symphysis, then following an Upper

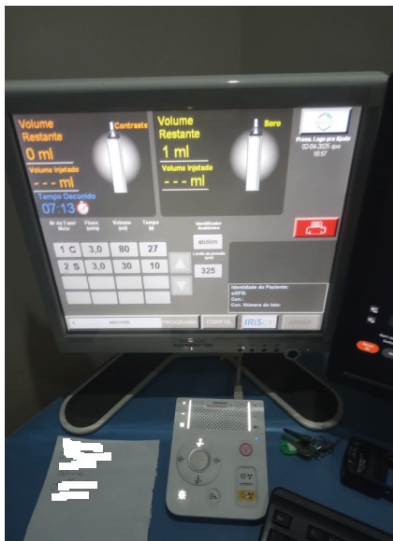
Abdomen Protocol, starting with a radiological technique of 120 KV, 300mA, 1.5 mm cut thickness, 3 mm for reconstruction thickness, using a Standard and Scout 180°-90° soft tissue reconstruction algorithm and a length of 500 mm. The contrasted phases were then carried out: For the Vascular Arterial Phase, where the contrast time inside the vessels acts around 25 seconds, in the second phase of the block we have the Visceral Arterial Phase, acting directly on the organs, with its interval time of 40 seconds, for the Pancreatic Phase 45 seconds, Venous Phase (liver and kidneys) 75 seconds, Renal Phase 90 seconds, Equilibrium Phase 3.5 minutes, and finally, the Excretory Phase (arriving at the bladder) in 5 minutes.



Workstation

In order to have a compression of the level of contrast deposited in the injection pump, working simultaneously with the serum (using the name Saline on the pump software screen), where the respective values were assigned: Speed was 5 ml per second in volume, Access with venous calibers, varied between 18, 20, 22 where the nursing team defined together with the operator in the type of exam, and to finish, Time (second), is the time that will last the entire administration of the contrast (used together with the Delay of the tomograph), in this case, we used 25 seconds of Delay (waiting time between the start of the contrast injection and the acquisition of the images), and for this we

needed a large flow of contrast, in this case we used 3 ml of contrast per second for this exam. We obtained the information for the appropriate volume of contrast by taking the patient's weight, which was 70 kg, from the patient's medical records, and using 1.5 ml multiplied by his weight, which was 70 kg. This meant that in order to have a certain rate of iodine delivery to the organ I needed to enhance, a total of almost 300mg of iodine per ml.

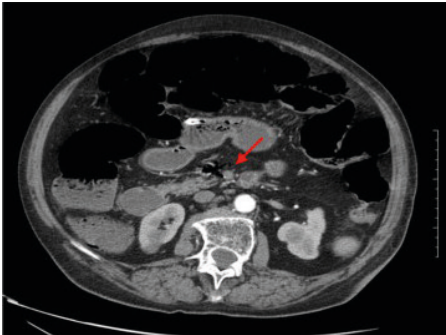


Injector pump platform

The National Cancer Institute (INCA) reports that ionizing radiation is radiation that has enough energy to remove electrons from atoms, thus creating ions (INCA, 2021). This energy is produced naturally or artificially, and can be electromagnetic or corpuscular in nature, i.e. formed by particles such as electrons, atomic nuclei, or other subatomic particles such as neutrals. However, electromagnetic radiation is used in tomography to guarantee diagnostic examinations. The National Nuclear Energy Commission (CNEN) establishes in its Nuclear Standard the basic requirements for radioprotection and radiological safety of radiation sources (CNEN NN 3.01) with various objectives, including protecting people from the biological effects of exposure to ionizing radiation.

When CT performs a contrast abdominal examination (non-ionic, low-osmolality iodine), with an indication for mesenteric artery ischemia, a life-threatening condition for the patient, it can be acute or chronic, early or late. For patients who manifest themselves with nausea, vomiting, diarrhea, abdominal distension, these are indicators of the acute form. However, signs of weight loss and loss of appetite can be included as chronic.

It's important to note that when a patient arrives at the tomography department for a scan, the team doesn't know anything about the patient's clinical condition. However, with the request made by the doctor and the clinical indication, a guide will be given to the structure to be studied.



Example of an axial CT scan with acute mesenteric ischemia



Example of a coronal CT scan with acute mesenteric ischemia

RESULT

This work was structured using equipment for image acquisition using ionizing radiation, within the techniques of radiological protection, enabling safe and effective diagnosis, as well as providing content in protocol models for operational performance.

Another important aspect is the operation of the contrast injection pump, a piece of equipment attached to the CT scanner, which works simultaneously with the request to inject iodinated contrast into the patient's bloodstream in order to better visualize the structures studied in the organs and vessels. Its operation controls the speed and quantity introduced into the patient, as well as ensuring that no professional is subjected to high doses of radiation.

CT image acquisition protocols must be acquired according to the needs of the exam, for each brand of device, each type of equipment, including channels:

As it is an abdominal exam, the first preliminary acquisition should be done in the supine position just to have the first scout from the pubic symphysis to the region of the hepatic dome, cut between 1.25 and 2.5 mm, for the iodinated contrast shot you should have a threshold of 120 UH from the beginning of the abdominal aorta, start the portal venous phase in 50 seconds then the arterial phase.



Tomograph coupled to an injection pump with a patient positioned

For the first group, the arterial phase, a scanning plane should be placed, cutting above the diaphragmatic domes, up to the iliac

crest region, taking in all the kidneys. For the second group, the portal phase, an acquisition plane should be placed across the abdomen. In the portal phase, they will wait 40 seconds and only then will they acquire the portal phase. Once this is over, they should wait another 230 seconds and do a late phase. For the third group, the late phase, you should also place an acquisition plane all over the abdomen.

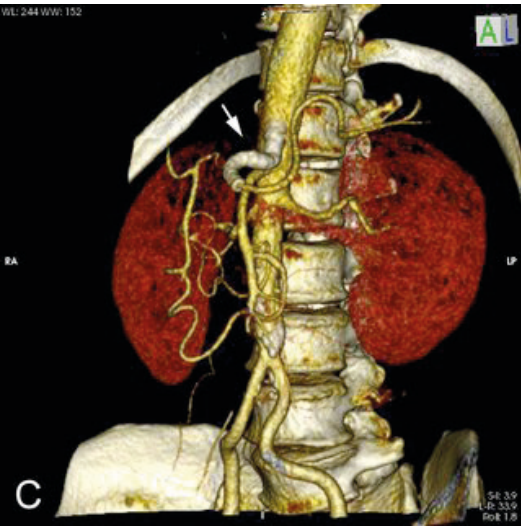
The radiation level factors for patients undergoing these procedures vary according to the patient's age, sex and weight. However, the dose rate varies in the range of 10 mSv (millisieverts). However, reducing the dose to the patient is an acceptable possibility depending on the change in protocol used by the CT scanner operator, such as increasing the rotation of the device (gantry), and decreasing equipment techniques such as mA (milliamperage) and KVp (kilovoltage peak). This protocol is necessary for Radiological Protection, as stipulated in the National Nuclear Energy Commission's BASIC RADIOLOGICAL PROTECTION GUIDELINES in CNEN Standard NN 3.01.



Initializing the procedure

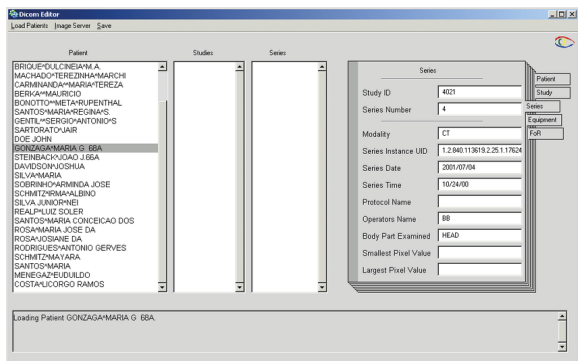
The 3D reconstruction technique within computed tomography software consists of the process of joining two-dimensional image slices, where the computer decodes the slices

and transforms them into three-dimensional images using algorithms. With these combinations, an excellent diagnostic tool is created, allowing for better clinical planning.



3D CT, mesenteric ischemia

The information technology (IT) sector allocates a cloud network system, and for this the DICOM standard is an important point, because in addition to allowing devices that work with digital medical information to communicate with each other, it makes it possible to store, along with an image, all the acquisition parameters associated with the image modality. Cyclops uses software called DicomEditor to read digital medical images and related information stored on certain servers.



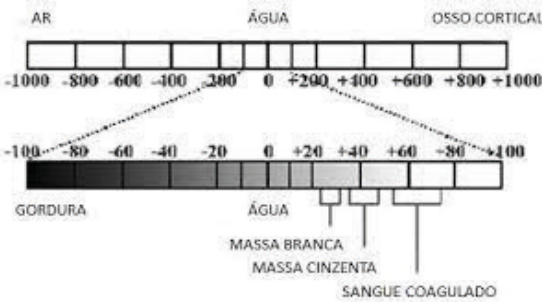
https://www.researchgate.net/figure/Cyclops-DicomEditor-um-cliente-DICOM_fig2_262817389

DISCURSION

In this work, we sought to highlight the importance of having an experienced technician with good strategic skills, aligned with the radiologist, who is by their side, for immediate communication, which can make a difference in the logistics of treatment, even though ischemia of the superior mesenteric artery is a very serious case, when visualizing the structures, the radiologist immediately reports it and releases it to the RPACS network system, reaching the requesting doctor as soon as possible, for the appropriate procedures, which can save the patient's life in a matter of minutes.

Therefore, it will be able to train professionals who use this tool to seek agility, technical, technological and didactic knowledge, helping the radiologist, offering a quality service, saving lives, improving knowledge and continuing to qualify this health institution as a reference in diagnostic imaging.

We highlight the importance of having a multidisciplinary team, both for the clinical picture and for those who use technology for image processing, looking for mesenteric lesions, which should be treated individually, with high success rates, lower morbidity and mortality and good short-term seriousness. It is also important to pave the way for new work, with other models of implementation in the speed of information passed on with agility, speed, efficiency and a safe diagnosis.



Variation in shades of gray between + 1000 and - 1000 on the Hounsfield scale

In the CT scanner software there are numerous tools for the synchronization and performance of procedures, one of which is windowing (collimation). However, we need to window because although the density varies from one thousand to one thousand, that is, there are two thousand different possibilities, where the human eye cannot see all of this, seeing only a few shades of gray. However, when carrying out the examination procedure triggered by the measurement, choosing the window too wide, leaving the shades of gray distributed from one thousand to one thousand, distorting the soft parts such as fat, leaving the shades of gray very close to each other, there is no possibility of differentiating, where we call the WIDTH (WW) and HEIGHT-LEVEL-CENTER (LEVEL / WL).

Therefore, if we leave the window wide open, all the soft parts in the sample will have the same shades of gray, very close to the tone of the fat, you can still see the bone very white with + 1000 and the air very black with - 1000, where the fat tends towards gray, the air tends towards black and the 0 (zero) which is at the middle point of the scale which is water with a medium shade of gray. However, in order to choose a window, given that there are various structures in an abdomen such as the spleen, liver, kidney, fat, stomach, water, etc., a narrower window was chosen between + 200 and - 200 at the limit between + 50, allowing us to see the structures very well, being able to see the fat through the kidney, the fat of the peritoneum more black, the wall of the stomach, where the air continues with a strong black tone, the bone with a strong white tone. (BONTRAGER, 2015).

However, what was relevant to this study, the procedure to be visualized, must be compatible with the patient's clinical indication: abdominal pain, extended abdomen, vomiting, fever, nausea, sweating, analyzed aspects such as visualizing a mucous and acerous layer, managing to delimit intestinal pneumatosis, originating gas in the tributary and venous system, lighting up to the liver, thus originating a mucosal lesion due to ischemia. The importance of the window game in the evaluation of mesenteric ischemia with a more open window, almost of bone, going out to a conventional abdominal window, going to a lung window, was the milestone for the diagnosis.

CONFIRMATIONS

- To the Imaging Center - Regional Emergency Coordination - CER of the Albert Schweitzer Municipal Hospital - HMAS

"Have you ever thought about how your dedication can transform the lives of so many people?

How many times have you brought relief, confidence and hope to those who need your care?

Can you imagine how many patients and family members have found the support they so desperately needed in you?

It may be difficult to measure this impact, but believe me:

Each person who received your care will remember how essential you were.

Your work is truly significant!

Keep going, because there are still many lives to be touched by your presence.

Dra. Sandra Valeria Francisconi Santos

Coordinator of the Continuing Education Center (CCDTI)

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