Detection Signal Thrombus from Magnetic Resonance Images on Small Abdominal Aortic Aneurysms

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Abstract

The big risk of aneurysms on aorta is that they can leak or burst and, without treatment, this is fatal because of bleeding from the aorta into the surrounding tissues and can be reason for the sudden death. Aortic aneurysms are often associated with the thrombus in it. Magnetic Resonance Image (MRI) is one of the very best digital examinations to observe the aorta that have many small tissues. This study is to detect a thrombus in the Small AAA from MR images using DICOM-work and MatLab Software. Data were obtained from 16 patients with Small Abdominal Aortic Aneurysms (SAAA) who had been examined since July 2006 to January 2010. DICOM is the standard for Digital Imaging and Communications in Medicine that can covers most image formats for all of medicine and have specification for messaging and communication between imaging machines. T1 and T2 weighted images have been processed and used to analyze the thrombus signal. To process all the data, we use MatLab software. Algorithm to obtain images from DICOM that store in a directory was developing. Manual tracing of the borders have been done to define the Aorta Surface and Luminal Surface in order to determine the Thrombus surface, where Thrombus Surface = Aorta Surface-Luminal Surface. We found 13 of the 16 patient with SAAA had a thrombus. By using DICOM-work as intermediaries between digital examinations tool with the image processing tool is very helpful for doing image analysis.
Keywords: Small AAA, thrombus, MRI, T1 and T2 images, Dicom-work

1 INTRODUCTION

Blood is pumped by the heart into the aorta and reaches all parts of your body through progressively smaller branch arteries. The blood pressure refers to the pressure in the arteries which pushes the blood forward. Blood reaches all the cells of your body through tiny vessels called capillaries. It then returns to your heart through the veins and picking up oxygen on its way through the lungs.

1.1 Aneurysm

An aneurysm means ballooning on artery, caused by weakening of the wall of artery. The pressure of the blood inside the artery can be causes the weakened of the artery wall and develop into swelling. Aneurysms are most often happen in the aorta, especially at the back of the abdomen. Occasionally aneurysms can occur in other parts of the aorta, or in other arteries, but the abdominal aorta is the most common place. Having an aneurysm usually causes no symptoms at all, so most people with aortic aneurysms have no reason to suspect that they have a problem.

1.2 Abdominal Aortic Aneurysm (AAA)

Abdominal aortic aneurysms are commonly abbreviated in medical writing to 'AAA' or 'triple A'. The big risk of aneurysms is that they can leak or burst and, without treatment, this is fatal because of bleeding from the aorta into the surrounding tissues and can be reason for the sudden death. For deciding whether and how the best way to treat an aortic aneurysm to prevent its rupture is very difficult, because the treatment of aneurysms also has risks.

The normal diameter of abdominal aorta is usually about 2–2.5 centimetres (cm) . The size very varies, depending on individual. The aorta of a small woman is just 1.5 cm, but the aorta of a big man is could be 2.5 cm. If the diameter of the abdominal aorta is greater than 3 cm then it is said to be aneurysma, but at that size there is no danger of the rupture. Another medical word sometimes used for an aorta that is abnormally wide or Small Aortic Abdominal Aneurysm (SAAA). If the aorta enlarges

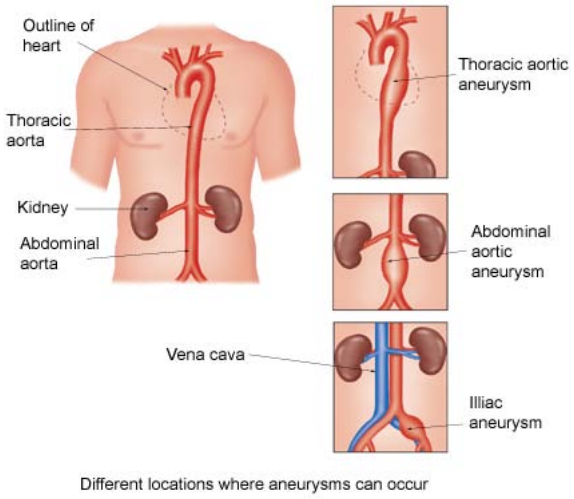

Figure 1: Locations where aneurysms can occur

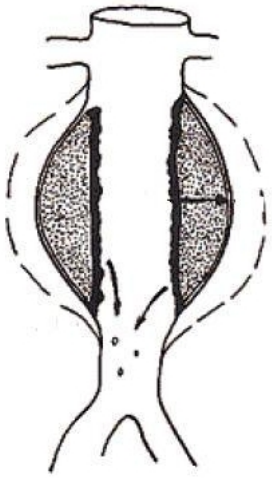

Figure 2: Aneurysms with a formation of Thrombus

up to 5 or 6 cm, then will be a rupture risk.

Some aortic aneurysms are discovered at very large sizes (for example, 10 cm diameter or more), without symptoms and no rupture. It is hard to predict whether an aortic aneurysm will be grow and rupture. Usually, the evolution of the diameter about two to three millimetres per year, but sometime evolution will stop and never reach a size at which treatment needs to be considered. Hence, a routine examination is needed to observe the evolution of aortic diameter

1.3 Thrombus Signal

Thrombosis term will refer to the formation of a blood clot (thrombus) in the blood vessels or the heart cavities in living systems. Aortic aneurysms are often associated with the thrombus (clots) in it. This is according to the facts that have been studied and demonstrated by the field of pathological, surgical, and clinical examination based on the results of computed tomography (CT), ultrasound imaging, angiography, traditional spin-echo (SE) or cine-MRI.

Lots of methods are created or modified in order to help to prove the existence of intact thrombus signal in the aorta. But until now, with a disorder that occurs in the aorta, it is difficult to detect or properly evaluate the existence of thrombus signal.

1.4 Magnetic Resonance Image

Magnetic Resonance Image (MRI) is one of the very best digital examinations to observe the aorta that have many small tissues. MRI is an imaging technique that takes advantage of the property of certain atomic nuclei (in this case, the single proton that forms the nucleus of a hydrogen atom) to vibrate, or resonate, when exposed to bursts of magnetic energy. When the hydrogen nuclei resonate in response to changes in a magnetic field, they emit radiofrequency energy. The MRI machine detects this emitted energy, and converts it to an image.

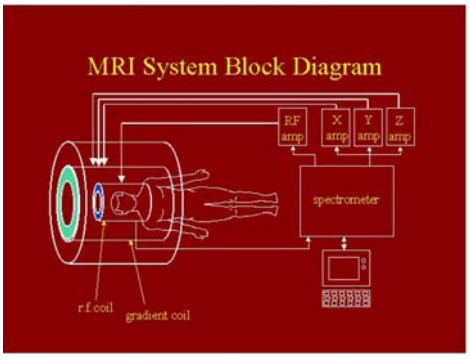

Figure 3: MRI System Block Diagram

Unlike CT where the image appearance is related primarily to the electron density of the material, MR images depend on many variables including proton density, T1 and T2 relaxation effects, flow effects, diffusion effects, and susceptibility effects. There is interdependence of the SNR, resolution, and time of acquisition.

2 OBJECTIVE

This study is to detect a thrombus in the Small AAA from MR images using DICOM-work and MatLab Software.

3 DATA AND METHOD

3.1 Data

Data were obtained from 16 patients with Small Abdominal Aortic Aneurysms (SAAA) who had been examined since July 2006 to January 2010. Each patient has had an examination at least 1 to 4 times with an examination every 6 to 12 months (according to the patient). MR Images were acquired on a 3T Imager (Trio TIM, Siemens Medical Solution, Germany).

3.2 Protocol Small Abdominal Aortic Aneurysms

In our research protocol, images allowing anatomy study, T1 and T2 weighted images were acquired. In particular, T1 and T2 weighted images have been processed and used to analyze the thrombus signal. For each patient, these images were located at the same position in one examination to another.

3.3 DICOM-Work

DICOM is the standard for Digital Imaging and Communications in Medicine. It developed by the National Electrical Manufacturers Association (NEMA) in conjunction with the American College of Radiology (ACR). Dicom can covers most image formats for all of medicine and have specification for messaging and communication between imaging machines.

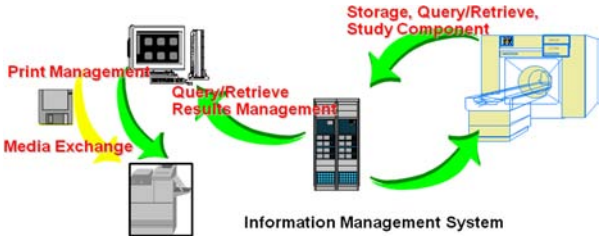

Figure 4: DICOM Application Domain

With DICOM we can choose the type of protocol on the MRI that will be used for analysis, such as the types of T1 and T2 weighted images, Blood Flow images, Images after injection, and soon.

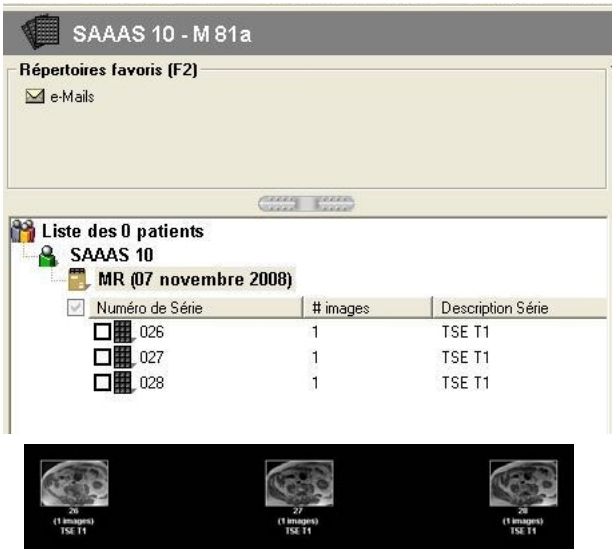

Figure 5: Patients List on DICOM

Then the picture that elected can we save it to the destination directory with various file formats, such as below:

Figure 6: DICOM Exporting File

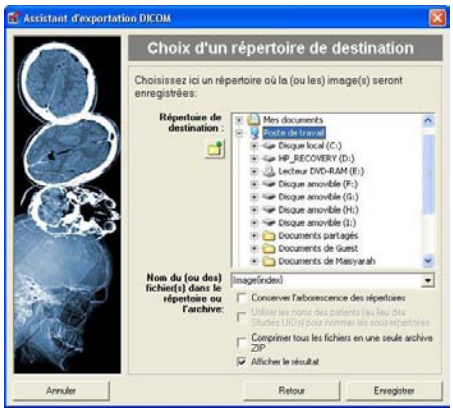

Figure 7: DICOM Exporting File (Destination directory)

3.4 Processing

To process all the data, we use MatLab software. Processing was done in the first examination in order to predictive aspect of early examination, and also done in the last Examination who have more thrombus important, more areas, and more signals.

Algorithm to obtain images from DICOM that store in a directory:

- Finds and returns the list of DICOM files in the file given as parameter.
- Restriction to files inside the folder, not subfolders
- DICOM format files have no extension or an extension (.Dim /. Dc3 /. Dcm /. Ima)
- Check whether the file is not a folder or a shortcut
- Adds the file to the list

Manual tracing of the borders have been done to define the Aorta Surface and Luminal Surface in order to determine the Thrombus surface, where

$$ThrombusSurface = AortaSurface - LuminalSurface. \quad (1)$$

Algorithm to calculate the surface of the aorta, the luminal and the thrombus:

- Calculating the ratio between T1 and T2 images
- Calculation of the surface of the aorta and the luminal in T1 and T2 images

$$matriceAorteT1 = imageCouranteT1(logical(BWaorteT1)) \quad (2)$$

$$nbPixelsT1 = length(matriceAorteT1) \quad (3)$$

$$surfaceAorteT1 = round(nbPixelsT1 * (ratioT1^2)) \quad (4)$$

- Showing of the surface of the aorta and the luminal in T1 and T2 images
- Calculates the difference between the 2 surfaces of the aorta and the luminal
- Calculation of thrombus on T1 and T2 and display image

$$surfaceThrombusT1 = surfaceAorteT1 - surfaceLumiereT1 \quad (5)$$

$$surfaceThrombusT2 = surfaceAorteT2 - surfaceLumiereT2 \quad (6)$$

- Calculate the average area of the thrombus from two thrombus that calculated in T1 and T2 images

$$SMT = (surfaceThrombusT1 + surfaceThrombusT2)/2 \quad (7)$$

- Display area on the T1 and T2 image

(a) Aorta Surface

(b) Luminal Surface

Figure 8: Manual tracing

To take into account of the aortic wall surface, thrombus was found if the thrombus surface area achieved > 30% aortic surface area.

4 RESULT

We found 13 of the 16 patient with SAAA had a thrombus. The comparison our result with the visualization result achieve 81% to the appropriateness level.

Here is a sample of T1 image which can describe about presence of thrombus in SAAA.

Figure 9: Surface thrombus : 243mm² (11,6%

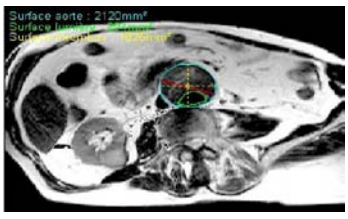

Figure 10: Surface thrombus : 1026mm² (48,4%)

5 CONCLUSION

By using DICOM-work as intermediaries between digital examinations tool with the image processing tool (such as MatLab) is very helpful for doing image analysis. In this paper, T1 and T2 images from MRI examination with DICOM format, has been used for detection of thrombus areas in Small AAA . For the future, we can use another image from MRI examination such as blood flow images to calculate the velocity of blood flow, blood flow volume and shear stress on the Small AAA, which can help to predict the rupture risk of the aortic wall.

6 ACKNOWLEDGMENT

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