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The Use of Manganese Nano-Molecular Solution as Alternative Contrast Media in CT-Scan Imaging

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Abstract

The alternative to the iodine contrast media which used in CT-scan, it is the only contrast media currently used to obtain X-ray images for all the body organs requiring more accurate diagnosis of certain diseases, especially tumors, urinary system, blood vessels and heart, has been studied. But iodine compounds may cause an allergic reaction for the patients to this substance or cause blood clotting or dangerous interferences with certain diseases such as kidney disease (kidney failure) and other symptoms which cause the patient to be prevented from accurately diagnosing the disease. The first alternative contrast media is manganese chloride nanoparticles ($MnCl_2$ NPs). The alternative nano contrast medium of MnCl2 NPs solution has been studied in good results comparative with iodine contrast medium especially in the heart organ by Hounsfield unit (HU) of CT-scan with the high resolution of imaging when using the low dose of alternative nano contrast medium comparing with native case and iodine contrast medium.

Keywords: $MnCl_2$nano solution, CT-scan,iodine contrast medium, Hounsfield unit, heart.

INTRODUCTION

It is necessary to think about finding an alternative contrast media to use in the Computed Tomography Scanning (CT-scan), as the some scientists have been carried out many studies in this field [1-6].CT-scan is a very useful technique which allows bones and hardened diseases such as cancers to be imaged because soft tissues are almost transparent to x-ray beams [7]. With CT contrast agents, however, soft tissues and blood vessels can be also imaged [8-9]. Contrast is a mean which allows us to differentiate between two or more adjacent elements on a radiographic study. There are two prototypes of X-ray contrast agents: agents (which increase X-ray absorption: Iodine or barium based); In patients with renal dysfunction or iodinated contrast allergy, the use of Iodinated Contrast Agent poses the risk of considerable morbidity [10].Contrast agents play an important role in high-quality magnetic resonance imaging (MRI) applications. Currently, Mn-based contrast medium with good biocompatibility and bright images are ideal for MRI. In addition, manganese oxide nanoparticles have attracted attention as T1 of MRI due to the short turn time and volume-controlled rotation time of colloidal nanoparticles. In recent advances in the use of MRI contrast agents for tumor detection and diagnosis, as well as advances in vivo toxicity, distribution and chemotherapy for enhanced tumor responsive to micro-environment and radiotherapy as well as photodynamic and photodynamic treatments are reported [11]. Iron

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oxide nanoparticles have been widely used as negative contrast agents T2 in magnetic resonance imaging. In the past few years, researchers have also exploited their application as positive T1 contrast agents to overcome the limitations of traditional Gd contrast agents. To provide T1 contrast, these particles must present certain physico-chemical properties while controlling the size, morphology and surface of the particles. T1 iron oxide nanoparticles are reported and critically review their properties, compositional protocols and applications, not only in MRI but also in multimodal imaging [12].

In this study, manganese chloride nano solution used as alternative contrast medium in CT-scan for heart organ of rabbits.

Experimental

Materials

Bayer Pharma AG Company from the German company (Berlin Germany) Iodine contrast as Iopromide (Ultravist 370) was used as contrast media in CT-scan. Manganese chloride ($MnCl_2$) was used from Chinese SCRC (China). Anesthesia materials used to anesthetize animals such as ketamine 10% from Alfasan Company (Holland), xylazine 2% from Alfasan (Holland). Blood samples of rabbits, and other chemicals and solvents were of annular grade and were used as received by the manufacturers. Deionized water was used to prepare aqueous solutions.

Preparation manganese chloride 0.5M $MnCl_2$

A 0.5 molar solution of pure manganese chloride (Chinese SCRC) was prepared in a 10 ml volumetric flask, and the crystals were dissolved in deionized water to obtain a 0.5 molar solution of manganese chloride which used as alternative contrast medium.

Lyophilization instrument

Lyophilization instrument from LABCONCO Company (USA) was used for the preparation of ceftriaxone nanoparticles from micro-particles by deep freezing technique as shown in Fig. 1.

Fig. 1. Lyophilization instrument, LABCONCO Company (USA) 2. ábraLiofilizálókészülék LABCONCO Company (USA)

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CT-Scan apparatuses

The CT-Scan screw type General Electric (GE) model TC Revolution EVO 128 Slices, GE Healthcare.

After preparing the rabbit for examination and in the case of anesthesia with the specified dose of the contrast, the rabbit was lying on the examination table to perform the spiral CT-Scan as shown in Figure 2.

Fig. 2 preparation the rabbit in CT-scan

Results and Discussion

Study the rabbits by CT-scan

The rabbits were chosen for a CT scan to check different organs of the rabbits' abdomen, especially the heart. The first group is the native (without contrast medium), the second group, in which the spatial survey of rabbits was studied using iodine contrast medium and the third group used an alternative contrast medium for manganese chloride nanosolution, where the heart of rabbits was studied via intravenous with the contrast medium at different doses of iodine contrast medium at (1, 2, 3, 4, and 5 ml) and for the alternative contrast medium of manganese chloride nano solution (0.5 M) of (0.5, 1, 1.5, 2, and 2.5 ml). Theexamination was performed following using CT-scanning.

CT-scan examination of heart organ

This examination was taken for all members of the abdominal area of the body of the rabbits such as heart for native case without using any contrast media, then the iodine contrast and the alternative contrast ($MnCl_2$nanosolution) were used for the examination was taken for the heart and kidney organs in the rabbits. The Hounsfield unit (HU) factor values can be used to determine the clarity of the CT-scan image.

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Hounsfield unit (HU): Absorption coefficient unit of radiolucency of a substance; HU is normalized to water, where water = 0 HU, air = -1000 HU and bone = 1000 HU [13], the HU values in the CT-scan are reported for each case taken for the studied rabbits as in the following:

1. The CT-scan imaging of the heart Tests were taken to turn the rabbits into the following three cases:

A. Checking the heart without using any contrast media (native case). It was found from the results as in Figure 3 of the rabbit's heart and the value of the clarity of the heart of the HU value was 46.1 as illustrated in table 1.

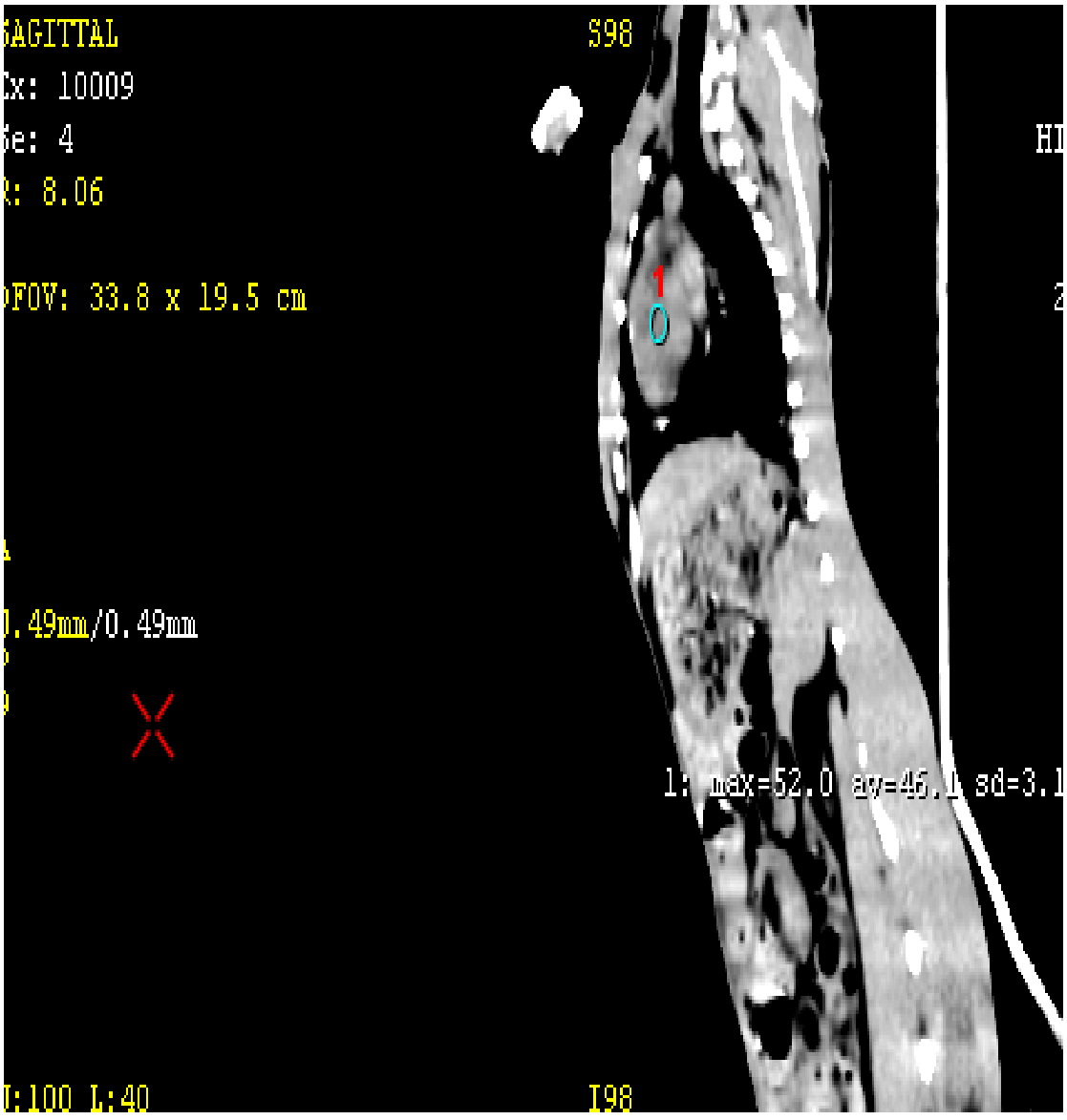

Fig. 3 native case of heart

B. The CT-scan of cardiac examination using an iodine contrast medium which illustrated in Figure 4a,b,c,d, and e with HU value of heart clearness have 51.2, 66.6, 83.7, 51.7, and 67.1 when using 1, 2, 3, 4 and 5 ml dose of iodine respectively, where diagnosis is possible.

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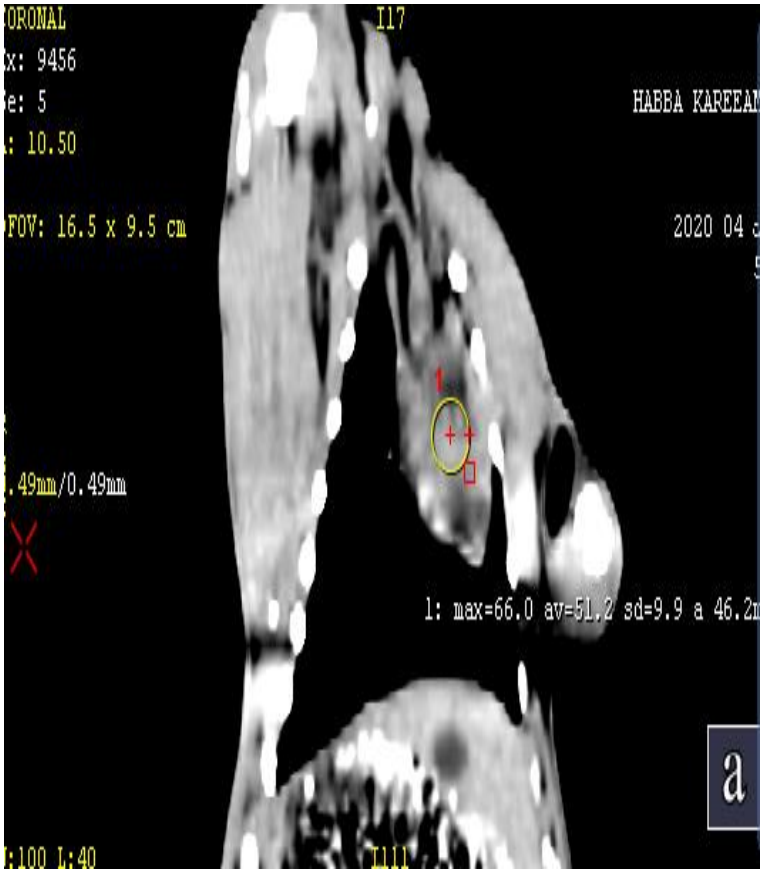

Fig. 4a iodine contrast medium in the heart

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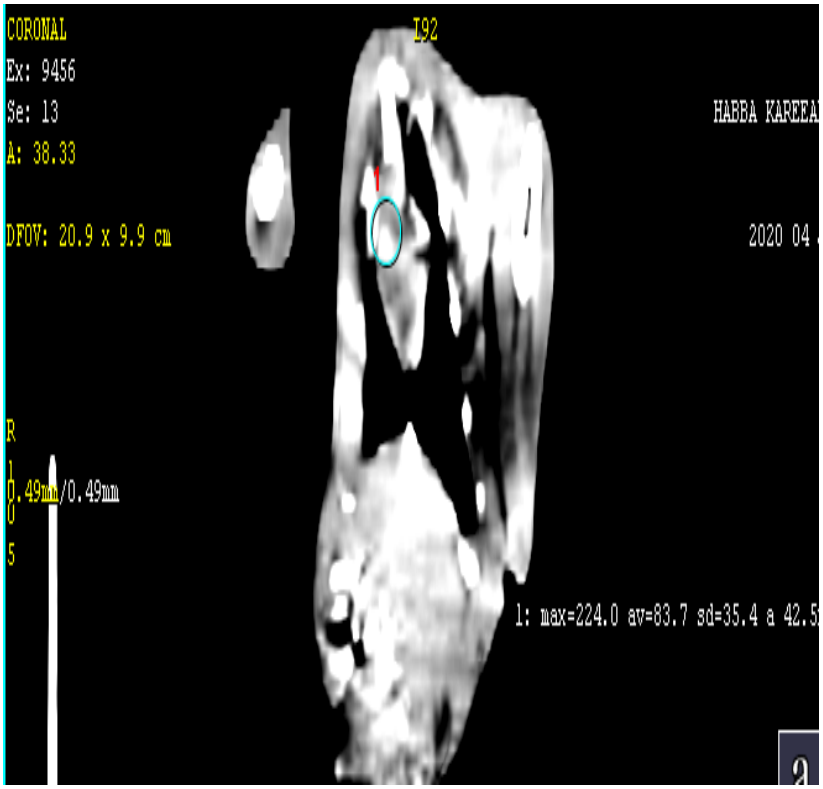

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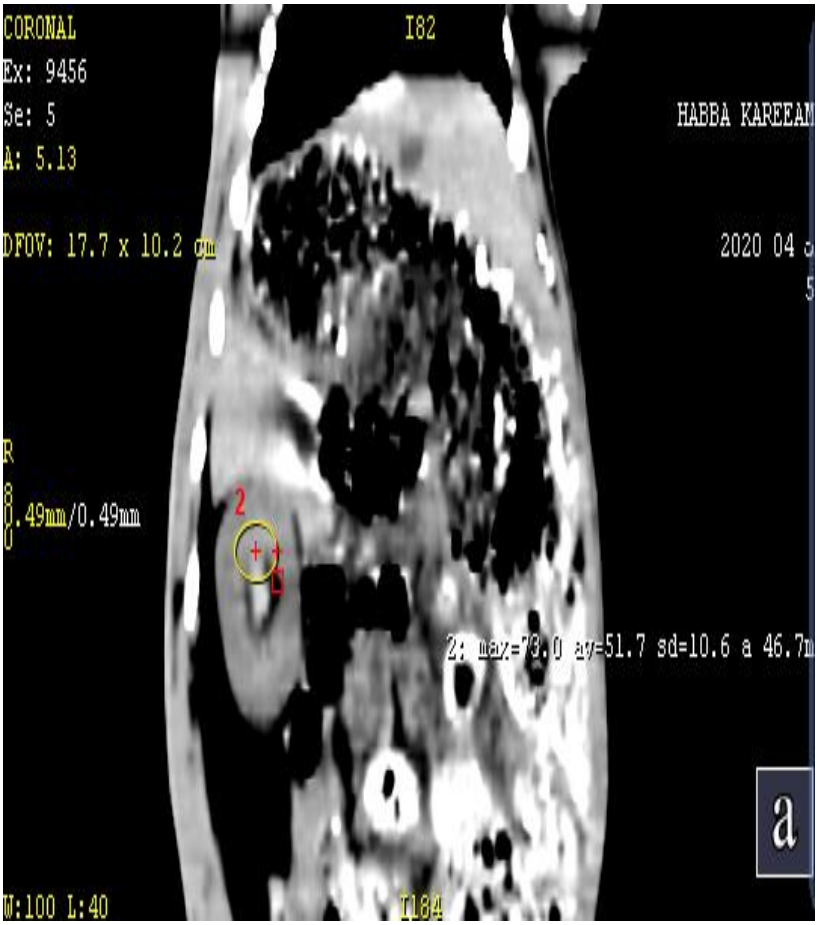

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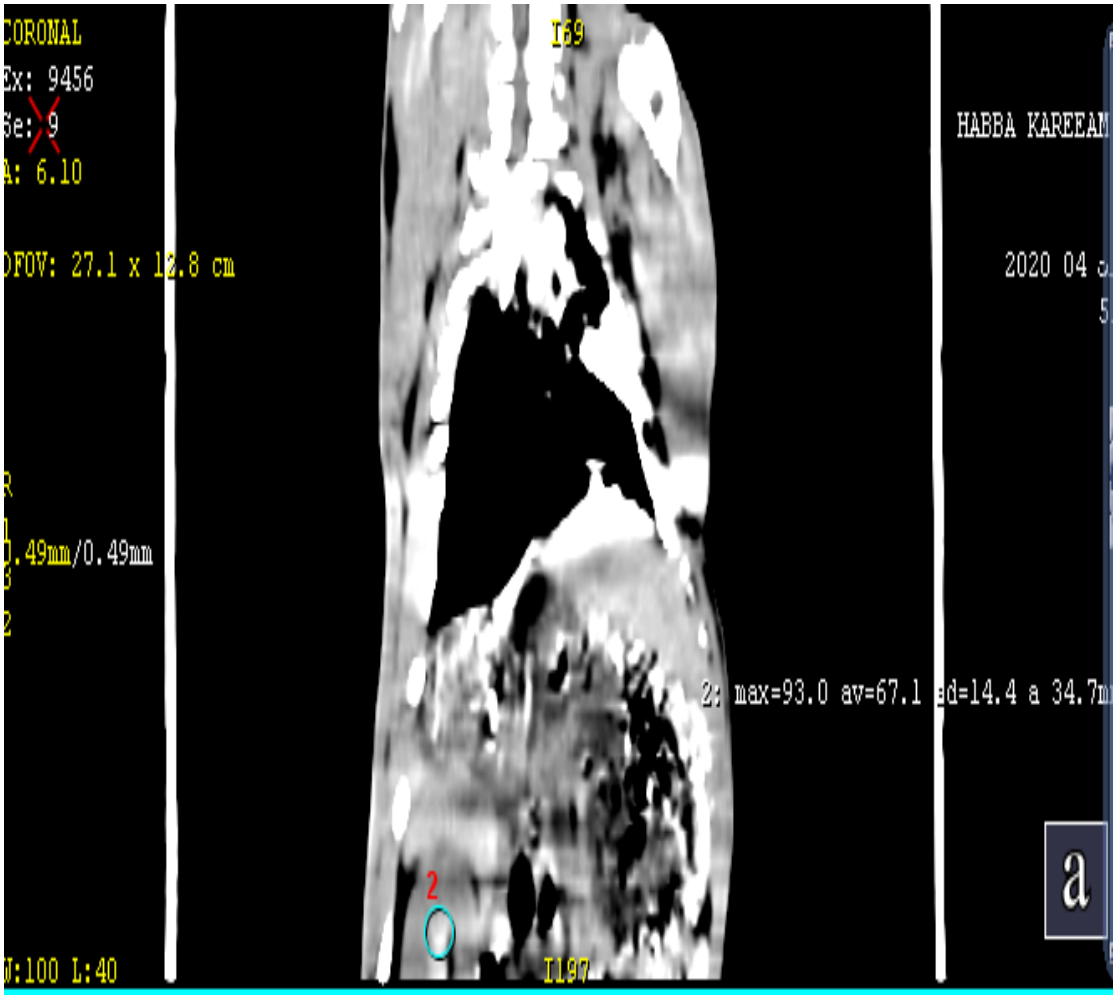

E

C. Cardiac examination using alternative nanocontrast medium of manganese chloride nanosolution which illustrated in Figure 5a, b, c, d, and e, it was found an enhancement of the heart CT-scan imaging by higher HU values compering with the HU values at iodine and native cases. Table 1 discuss the HU values when using alternative nanocontrast agent ($MnCl_2$nano solution) of 61.0, 68.4, 70.6, 76.1, and 83.2 at the doses of $MnCl_2$nanosolution (0.5M) of 0.5, 1, 1.5, 2, and 2.5 ml respectively, it is a good enhancement of CT-scanning when using the alternative contrast medium comparison with iodine contrast, moreover the safety of using $MnCl_2$nanosolution.

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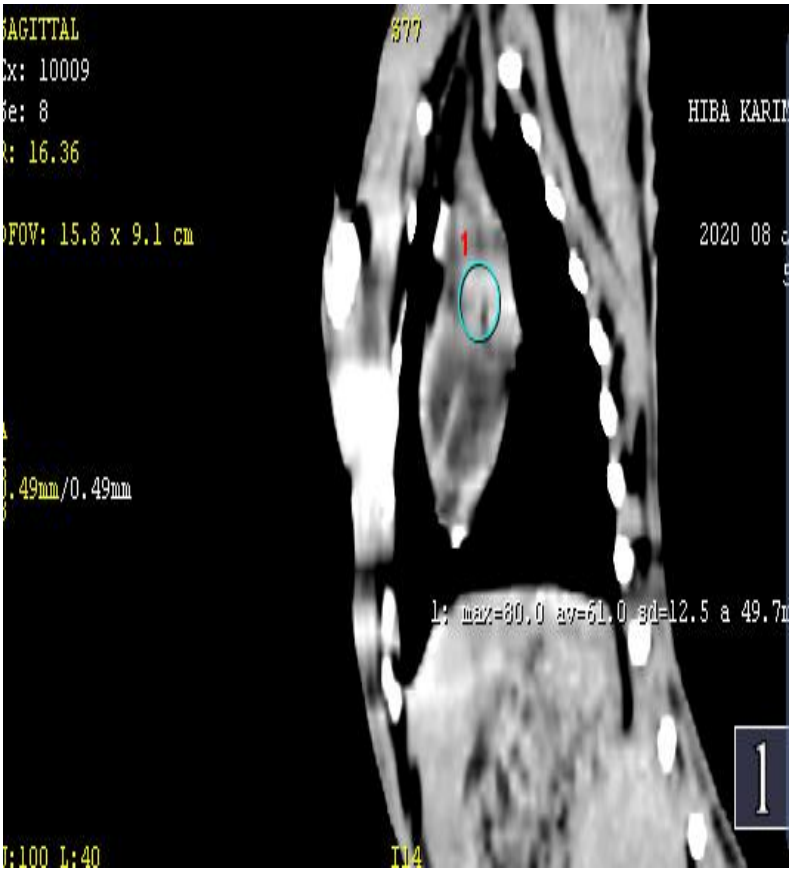

Fig. 5a using alternative nano solution of MnCl2 NPs (0.5ml) for the heart

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e

2. The CT-scan imaging of the cardio organ was taken to turn the rabbits into the cases. It can be seen when using the alternative contrast medium for the rabbit's heart organ when injected with different doses of this contrast at 0.5, 1, 1.5, 2, and 2.5 ml of 0.5 M MnCl2 NPs as shown in Fig. 6a, b, c, d, and e respectively. It was found from the results of the HU values from the table1 for the heart organ which have the values of 61, 68.4, 70.6, 76.1, and 83.2.

From the table 1 the results of HU values for the heart organ of rabbet which have good results when using the same dose of alternative nano contrast medium comparing with the results of iodine contrast, that all HU values have higher in alternative contrast.

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A

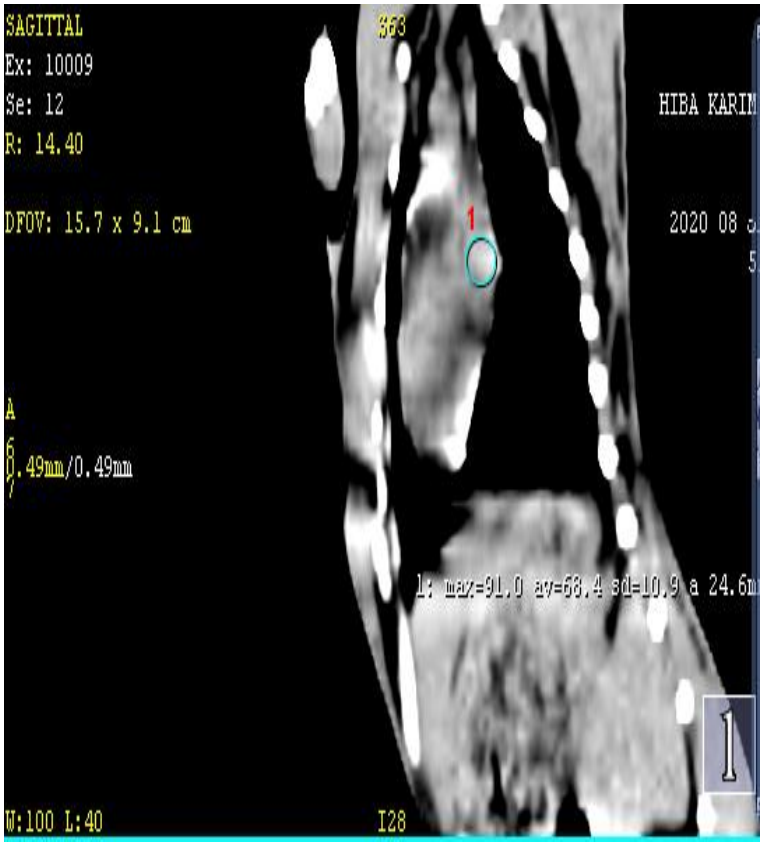

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Table 1: HU values of heart and kidney of rabbits at different contrast media

Contrast medium	Dose (ml)	Heart (HU)
Native	**-**	**46.1**
Iodine	**1**	**53**
	2	**62**
	3	**83**
	4	**95**
	5	**146**
$MnCl_2$ NPs (0.5M)	**0.5**	**61.0**
	1	**68.4**
	1.5	**70.6**
	2	**76.1**
	2.5	**83.2**

Conclusion

Through the study of alternatives to the contrast media whichused in imaging by CT-scan, for the emergence of many side effects when using iodine contrast medium, manganese compounds were studied and the nano formula was chosen to reduce the dose used and distinct results for

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micro-manganese and iodine contrast medium. It can be concluded that the use of nanomaterials as contrast medium in the CT-scan which gives better results than the use of iodine, since the nanomaterial gives high-definition images and at low doses.

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