F.jannath also makes it obvious to differentiate between

F. Jannath and A. Riaz prepared andwrote the report, Comparison of CT and MRI in vascular pathologies.

F. Jannathcarried out research of abdominal aortic aneurysms and the relevant cases. A. Riaz carried out research of renal artery stenosis and the correspondingcases.

AttributionsTakinginto account recent healthcare systems around the world, CT and MRI have provedto be the most reliable and efficient methods for diagnosis in various hiddenpathologies. The research conducted for this report was aimed for generalfeatures of CT/MRI and the corresponding vascular pathologies. ForRAS, considering the cases analysed, MRI gives a better definition of thepathology.

CT, on the other hand, clearly identifies the stenosis and positionand is also a reliable method to diagnose RAS. However, in my opinion, MRIlocates the precise position of the stenosis and also makes it obvious todifferentiate between the blood vessels. To conclude, for AAA’s, CT is the golf standard, it provides a more detailed scan as it has higherresolution. CT angiography determines the exact size of the aneurysm with closeto 100% sensitivity and specificity and also shows the involvement of anysurrounding anatomy. A vital difference between MRI and CT is that CT allows forthe detection of calcification. Which is an important feature in AAA’s as itaffects the peal wall stress of the aneurysm.

V.

ConclusionTablei Comparison of CT and MRI 16″Table1″ summarises the main differences of CT and MRI. Regarding image specifics, CThas higher

resolution and less motion artefact due to the nature of the speedof the scans. CT is excellent for visualising bones but also good forvisualising soft tissues, especially with the use intravenous contrast dye. MRIon the other hand is excellent for detecting slight differences between tissuesand it better than CT in providing higher detail in soft tissues.

The risksassociated with CT in terms of radiation are higher than MRI, as CT uses x-rayswhich are ionising, unlike MRI which uses magnetic fields and radio waves. However people may experience allergic reactions to the contrast dye used inMRI although it is rare, and also those suffering from kidney or liver problemsare not recommended to undergo an MRI scan as the contrast can be damaging. Allergic reaction due to contrast used in CT is also possible and is morecommon than in MRI because CT uses iodine in the contrast. CT scans are takensignificantly quicker than MRI scans, and therefore exposure to x-rays is notelongated. Whereas MRI scans can take up to 90 minutes and can also be noisyand uncomfortable. People who have metal implants inside their bodies such aspacemakers and some prosthetics are not suited for MRI, whereas CT is notsuitable for pregnant women and children because of the damaging radiation. Interms of cost, MRI is much more expensive as MRI scans are at a much largerscale and therefore more materials and equipment is required.

IV. Comparison Of Medical Imaging ModalitiesToexamine the two images (“ Fig. 5” and “ Fig. 6”) in contrast, both imaging modalitiesare reliable to detect and diagnose a renal artery stenosis. However, MRI givesa precise location and the size of stenosis whereas CT detects the presenceonly.

MRI provides more accurate information of quantity of blood vesselspresent, which is important information for the diagnosis and treatment ofstenosis. Also, MRI efficiently distinguishes between normal and abnormaltissues. ThisMRI image effectively identifies normal/abnormal tissue and blood vessels, withhigh definition. The size and location of the stenosis can be detectedefficiently. Furthermore, the image shows a dark/light left kidney, which implies a normal functioningkidney.

However, the imaging produced for the left kidney is of light grey, which suggests that this kidney is malfunctioning possibly due to the lack ofoxygenated blood. Figure 6MRI scan image of a 45 year old male 15 Analysingthe image further, the imaging produced shows a highly visible, white denseaorta. The surrounding blood vessels to and from the kidney are also highly visible.

A stenosis can be accurately detected in the artery leading to the left kidney. The exact location of the stenosis can also be determined for treatment. Considering another RAS case," Fig. 6″ shows an image of MRI scan that is taken from a 45 year old male withsymptoms relating to renal artery stenosis. The image precisely shows thelocation of the kidneys and surrounding tissue.

Imaging of numerous bloodvessels is also produced by the scanner. The size of the kidneys can beaccurately measured and compared using this MRI image. ThisCT image visualizes clearly large organs, tissue and blood vessels. Thepresence of stenosis can be easily detected. The sizes of the kidneys can alsobe measured (not accurately). TheCT image produced by

the scanner reveals complete occlusion of the left renalartery. Due to the narrowing of the arteries, the image shows a ‘ blank blackpart’, which leads us to believe that stenosis of the artery has occurred.

Furthermore, the left kidney does not appear to be fully grey as the rightkidney. This suggests damage to the kidney tissue due to lack of oxygenatedblood in the left kidney. On the other hand, the image of the right kidney(light/dark grey) suggests a normal functioning kidney.

The blood vesselslinked to the right kidney are also visible.
Discussing vascular pathologiesand their diagnosis in further detail, “ Fig. 5” shows a CT scan image takenfrom a 65 year old male, with symptoms of renal artery stenosis.

The two kidneysare easily visible in the image. Surrounding organs and tissue or fluid arealso visible, mostly in light/dark grey colour. The dense white part leading tothe kidneys is the aorta. Figure 5 CT scan image of a 65year old male 14 B. RenalArtery Stenosis Thetwo modalities are both sufficient in identifying the AAA and determining itssize. However, CT demonstrates higher contrast and therefore important detailssuch as calcification can be identified.

Herein “ Fig. 4” the lumen can be seen and hence the diameter of the AAA can bemeasured. Figure 4 MRI scan 13 “ Fig. 3” shows an MRI scan of an AAA, of a 65 year old male. The MRI visualises thesoft tissues and the surrounding anatomy. The kidneys can be seen as well asthe renal arteries, so any involvement of surrounding anatomy in thedevelopment of the AAA can be determined. The AAA itself can be identifiedbecause of the contrast

between the organs which are darker and the arterieswhich are brighter and the dilation in the aorta is very clear. However to beable to determine if there is thrombosis or calcification and also the diameterof the aneurysm a cross sectional MRI is required.

Which is shown in Figure... Figure 3 MRI scan image of 65 year old male 13 " Fig. 2" also shows a CT scan of amale with an AAA. Similarly, to figure ..., the aorta is clearly visible andtherefore diameter of AAA can be measured. Surrounding the aorta iscircumferential mural thrombosis, this occurs in 70%-80% of AAA patients and can cause hypoxia in places wherethrombosis entirely covers the aorta. This can also contribute to stress in thearterial wall. The contrast between the aorta and thrombosis is very highallowing them to be distinguished from each other. The small white dots surroundingthe thrombosis called calcification are calcium deposits which increase peakwall stress. Thrombosis and calcification are both considered in the evaluationof wall stress for the risk assessment of AAA rupture which is why it is highlyimportant that these features of AAA can be identified in screening.

Figure 2 CT scan image of a male 12 " Fig. 1" shows a CT scan of a 70 year old male with AAA. Theaorta is clearly visible hence the diameter of AAA can be measured. The grey area surrounding theaorta is a fat strand, which suggests a containedrupture as no extensive retroperitoneal haemorrhage Can be seen, the haemorrhage would have been characterised Anintra-luminary and extra-luminal air crescent is also visible. Moreover, there are extra-luminary air bubbles, which also suggest apossible leak of the aneurysm. These findings highly suggest an infected AAA, with gas

producing bacteria. Surrounding anatomy can also be observed from thescan, and the spine is clearly visible as it is bright white.

Figure 1 CT scan image of a 70year old male 11 A. AbdominalAortic Aneurysms

III. Diagnosis Of Vascular PathologiesFor the diagnosis of AAA and RAS, MRI is considered to beone of the most useful imaging modality. It accurately identifies abnormal bloodvessels and tissue. MRI is highly recommended and used in the diagnosis ofvascular pathologies. It is suitable to examine the brain and many internalorgans due to its ability to define anatomy extensively. Also suitable toexamine blood vessels for blood flow.

Although MRI is costly, it is greatlyused worldwide seeing that it uses non ionizing radiation throughout theprocess (which is harmful for human health). Two thirds of the body is made of water (oxygen andhydrogen). The protons located in the centre of the water molecules are highlyattracted towards a magnetic field. During an MRI scan, the scanner produces astrong magnetic field. This causes the protons in the body to line up. Shortbursts of radio waves are then sent to certain parts of the body which are tobe examined causing the protons to be knocked off alignment. The radio wavesare then turned off resulting in the re-alignment of the protons.

Consequently, radio signals are produced which determine the exact location of the protonsand are detected by the receivers 10. Magnetic resonance imaging (MRI) is a type of diagnosticsan that uses strong magnetic fields and radio waves to produce detailed imagesof inside the body. It measures properties of high hydrogen tissues. MRI can beused to examine almost

anybody part such as bones, tissue, muscle, bloodvessels, brain, heart, lungs and breasts. The person to be examined is laidflat on a bed. The bed moves inside the scanner. The scanner is controlled by acomputer. B.

MagneticResonance ImagingThe cross-sectional images generatedduring a CT scan can be reformatted in multiple planes, and can generatethree-dimensional images which can be viewed on a computer monitor, printed onfilm or transferred to electronic media. CT has proved to be highly effectivein the diagnosis of abdominal aortic aneurysms and renal artery stenosis due toits imaging properties. Differences between normal/abnormal blood vessels andtissues is efficiently distinguishable through CT with the aid of processingtechniques. CTin the recent years has allowed detailed evaluation of vascular diseases. Multiphase contrast enhancement plays a particularly important role inrevealing abnormalities associated with these diseases 9. Usually a dye is injected to the patient to aid multiphase contrast enhancementand show blood flow.

Recent implementations in CT include post-processingtechniques, such as multi planar reformatting, shaded surface display, maximumintensity projections, and 3D perspectives of surface and volume rendering, which simulate virtual intravascular endoscopy. Computed tomography (CT) is a diagnostic imaging test used to createdetailed images of internal organs, bones, soft tissue and blood vessels. Italso one of the best methods to detect the presence of a tumor and determinethe precise size and location 8. The CT scanner looks like a big doughnut. The scanner includes an x-raytube on one side and a detector mounted on the other side. The patient liesdown inside the patient aperture which is normally 60cm to 70cm in diameter.

Anarrow beam of x-rays is produced by the x-ray tube as the scanner rotates aroundthe tube and detector. This beam rapidly rotates around the body. Eachrotation is of 360° and takes about one second. The detector records the x-raysexiting the patient’s body and creates a snapshot at one position.

Manydifferent snapshots are created during one rotation. The data are sent to acomputer which reconstructs all the snapshots and creates a ‘ slice’ image ofthe particular body part. Computed tomography works on the x-ray principle.

Depending on the amount of absorption, different amounts of x-rays will passand leave the respective parts of the body A1. Dense bones absorb most of the radiation, while soft tissue and fat allow most of the x-rays to pass through them. Therefore, bones appear as white on the x-ray mage and tissue appear in shadesof grey. A.

ComputedTomography

II. Medical Imaging Modalities Theimaging techniques used to diagnose renal artery stenosis also vary, the mostcurrently used method is intra-arterial digital subtraction angiography 7. The gold standard for the diagnosis of RAS isconsidered to be invasive angiography. Similarly to abdominal aortic aneurysms, ultrasonography is also used to screen for RAS, and the lack of ionisingradiation makes this method much safer. The type of ultrasonography used iscalled duplex ultrasonography, where peak systolic and end diastolic velocitiesof the renal artery and the ratio of velocities in the renal artery to theaorta are obtained.

This method boasts high sensitivities of 92. 5 to 98% and specificitiesof 96% to 98%. Several factors however can reduce the image quality such asobesity and recent food intake.

Dueto the high mortality rate associated with AAA’s, it is essential that they arediagnosed accurately and early to prevent further complications and to improvethe outcome of the patient’s health. The main roles of imaging in AAA diagnosisare; the detection of AAA, monitoring the growth rate of the aneurysm, preoperative planning and postoperative follow-up. History of AAA’s show thatas the aneurysm expands in size, the rate of expansion becomes greater andtherefore the likelihood of a rupture also, which is why regular monitoringusing imaging is required 5. In England, screeningfor AAA is offered to men once they turn 65. The screening is highly encouragedespecially for those who have a history of smoking. The screening involves aquick, painless ultrasound of the tummy and is very important in identifying anAAA before it becomes bigger or bursts.

Ultrasonography is the standard methodused in the diagnosis of AAA and in the monitoring of any known AAA’s and has ahigh sensitivity of nearly 95% and specificity of nearly 100%. Aortography has also been used in thediagnosis of AAA’s, in the past to evaluate the stage of AAA’s before operatingand more recently to address issues not resolved by less invasive methods, issues such as; other nearby vessel stenosis’s 6. Another imaging modality used is CT, which is considered the imaging goldstandard, further advances in CT including helical CT and CT angiographyprovide significant advantages over traditional, such as the development of 3Dimages of the aneurysm and an ability to produce more rapid scans. Additionally, CT

angiography and aortography can determine the size andsurrounding anatomy of the aneurysm, which aids in the process of selecting theright candidates for the use of endovascular stent grafts. Renalartery stenosis is the narrowing of one or both the renal arteries. It is amajor cause of secondary hypertension and it is often caused by atherosclerosisin cases of patients older than 55, which is a hardening of arteries caused bya build-up of plaque, and less often by fibromuscular dysplasia, which is theabnormal growth of tissue within the artery wall, usually in younger patients 4. Secondary hypertension is unlike primaryhypertension, the most common form of high blood pressure for which the causeis unknown 5. The endothelial damage responsiblefor atherosclerosis is not clear, however some contributors may be; smoking, diabetes, viral infections and immune injuries.

Abdominalaortic aneurysms are quite common and can be life threatening. Aneurysms can besimply defined as a focal dilation in an artery, hence AAAs are a result of thedilation of 3cm or more of the abdominal aorta, which is located in thedistance between the diaphragm and the aortic bifurcation 1. The cause of AAA is the failure of the main structural proteins in the aorta; elastin and collagen, however the events that lead to this failure of theproteins are not yet fully known or understood. Although, some biologicalprocesses have been identified that contribute to AAA, these include; inflammation, vascular smooth muscle cell (VSMC) apoptosis, extracellularmatrix degradation and oxidative stress.

If left untreated and the expansion ofthe aneurysm progresses, the aortic wall continues to weaken and ultimatelybecomes unable to withstand the

blood pressure which will likely lead to arupture. AAA is asymptomatic and therefore many of them are identified viadiagnostic imaging, ordered for different reasons 2. Patients who are more prone to developing AAA are men older than 65 years whohave peripheral atherosclerotic vascular disease. A recent review found thatthe strongest risk factor for AAA that can be controlled, is smoking. Othersinclude, age, male gender, family history of AAA, coronary artery disease, hypertension, peripheral artery disease and previous myocardial infarction

3.

I. Introduction Abstract — The purpose of this report is to compare the featuresof CT (computed tomography) and MRI (magnetic imaging resonance) in thediagnosis of aortic aneurysms and renal artery stenosis and to determine whichmodality is more effective in diagnosing these diseases.

Both CT and MRI arewidely used in the medical setting as a tool to help diagnose vascularpathologies, including the ones discussed in this report. The features discussedinclude image contrast, spatial resolution, scan duration, risks associated etc.