Al-Mustaqbal University
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Radiological Techniques Department

Magnetic Resonance Imaging

First Semester

Lecture 4: MRI artifact during the exam : Types, Remedies

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Introduction:

Magnetic resonance imaging also suffers from artifacts as other radiological modalities. Artifacts can cause **significant image degradation and can lead to misinterpretation**. It is impossible to eliminate all artifacts though they can be reduced to acceptable level.

Scientific Content:

Artifacts may be defined as **the false features in the image produced during the imaging process**. Artifacts can be **rectified** easily when the causes are known.

- and these include the following:

1- Ghosts/Motion Artifacts:

Ghosts are replicate of something in the image. **Ghosts are produced by body part moving along a gradient during pulse sequence resulting into phase mismapping**. **Ghosts can originate from any structure that moves during the acquisition of data** (Fig. 1). Periodic movement such as **respiratory, cardiac and vessel pulsation** causes ghosts while nonperiodic movement causes a smearing of the image. **Artifacts can be classified into different categories**

-Axis: ghosts almost always seen along **phase encoding axis**.

-Corrective measures:

A-Patient motion: Make patient lie comfortably, stabilize, with straps and cushions, it is important not to use excessively long sequences, as movement for a brief period spoil all the images.

B- Cardiac motion : **This type of artifact is caused by the contraction and relaxation of heart (chest) while the scanning is going on**.

To avoid this type of artifact, **cardiac gating** is mandatory during the procedure.

C- Respiratory motion : This type of artifact is caused by respiration during the scanning. This can be avoided by **respiratory gating and respiratory compensation.**

D- Blood flow motion: This type of artifact is caused by the flow of blood throughout the cardiac cycle. The artifact is prominent in **axial images**. **An effective remedy for blood flow motion artifact is 'Spatial Presaturation (SAT)** which is a new technique for suppressing these artifacts.

In this technique a spectrally shaped radiofrequency pulse has been applied to selectively saturates spins located in regions outside the image volume.

Note: **Another way to reduce the effect of the motion artifacts** is by the using of **saturation band.**

-**Saturation Band It is also called REST slab or SAT band and is used to suppress the signal from a part of the FOV** (Fig. 2). A 90 degrees RF pulse is sent immediately prior to proper sequence tilting the magnetization in transverse plane in the region of the band. When proper excitation pulse follows there is no longitudinal magnetization in this region to be tilted. Hence this region will not have any signal.

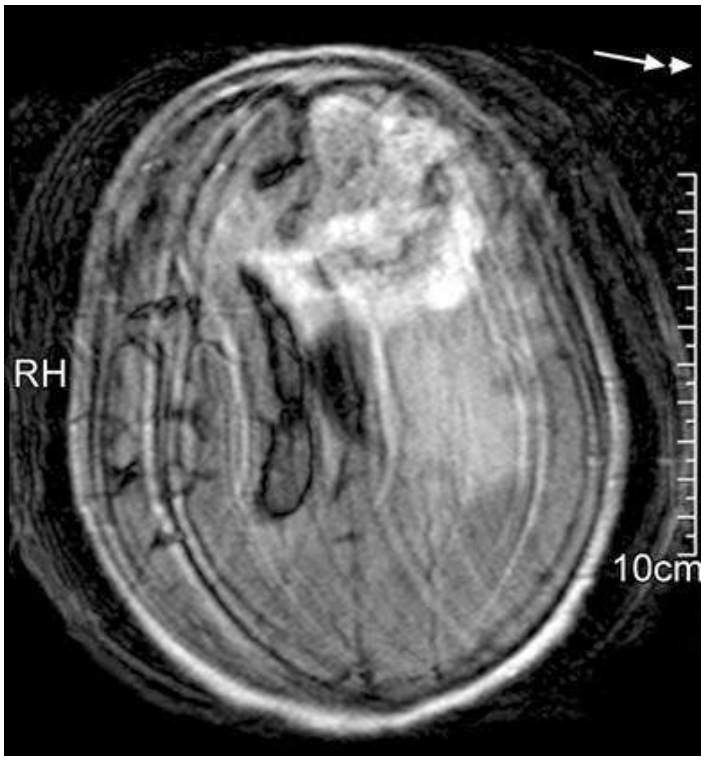


Fig.1: Ghosting/ Movement artifacts

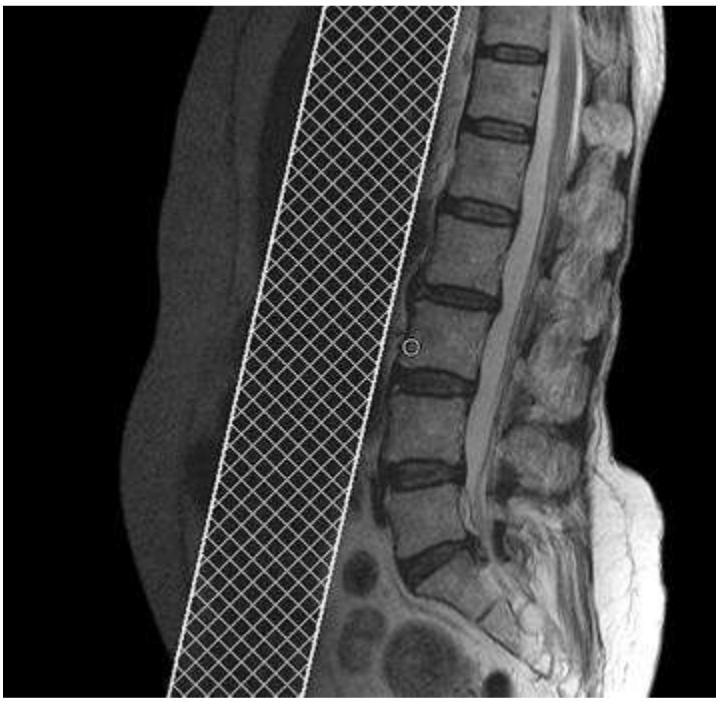


Fig. 2: Image showing saturation band anterior to the spine.

2- Aliasing/ Wraparound:

In aliasing, anatomy that exists outside the FOV appears within the image and on the opposite side (Fig. 3). When the imaging field of view is smaller than the anatomy being imaged, aliasing occurs.

-Axis: aliasing can occur along any axis.

Aliasing along frequency encoding axis is called **frequency wrap** and along phase encoding axis is called **phase wrap**. Aliasing can occur along slice selection axis in 3D imaging.

- Corrective measures:

A-Increase FOV.

B- Filtering the frequency encoded direction.

C- Phase wrap can be corrected by increasing FOV along phase encoding direction.

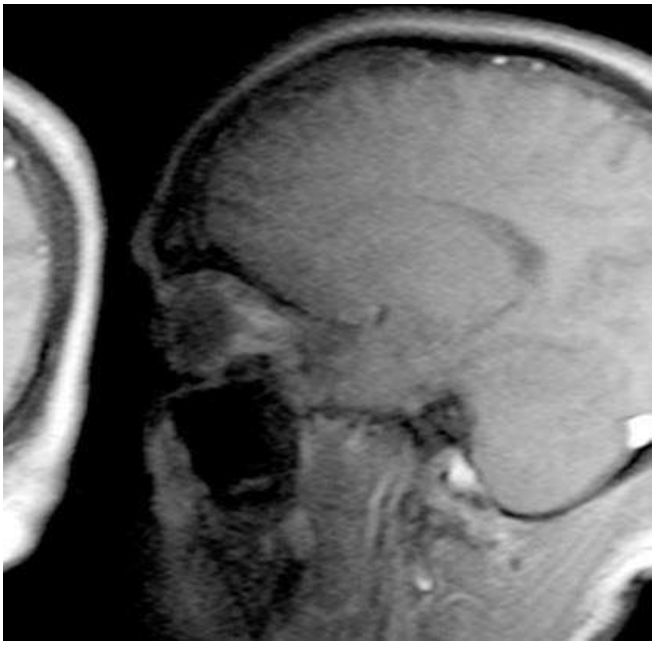


Fig 3: Aliasing artifact

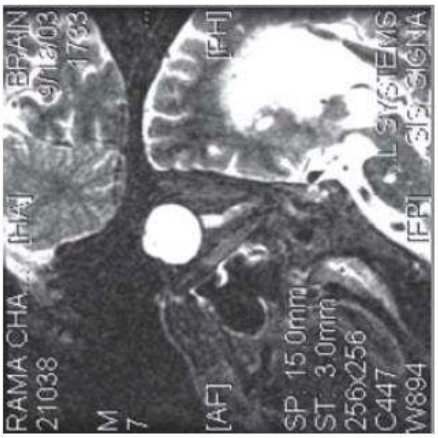


Fig. 7.1: FOV: 18 cm Aliasing of the back of the head onto the forehead in the phase direction is seen

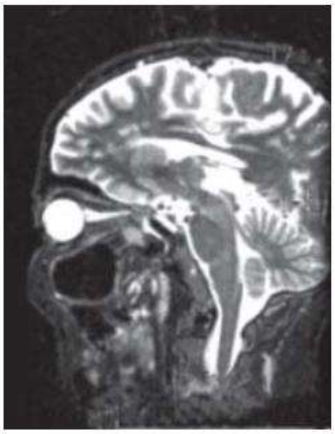


Fig. 7.2: FOV: 32 cm

Fig. 7.3: Back folding artifact

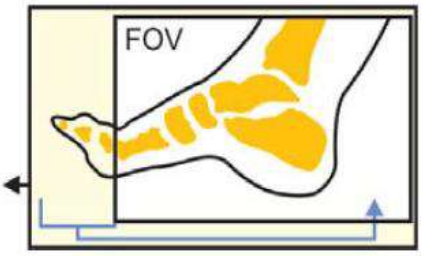
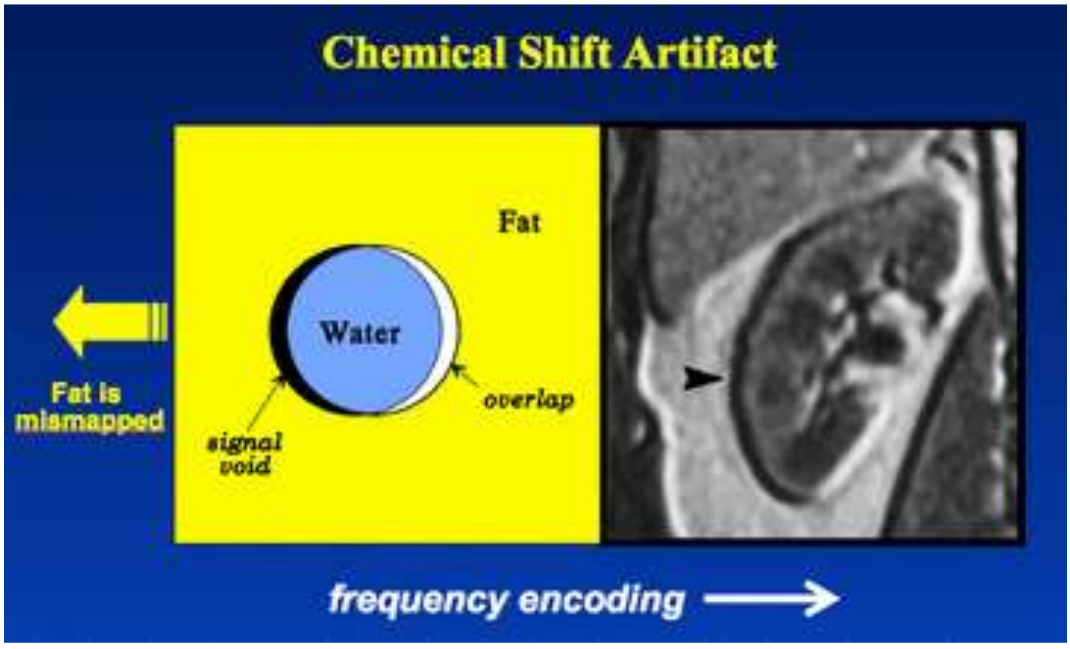


Fig. 7.4: Fold over artifact

3- Chemical Shift Artifacts:

Chemical shift artifacts appear at **the interfaces between water and fat because the precessional frequency of protons is slightly different in these two substances**. This leads to misregistration of the signals. They are displayed by the equipment as **dark region of signal void on one side of water containing tissue and a region of bright signal at the other end of the water fat interface due to super imposition of fat and water signals on the frequency encoding direction.**

The chemical shift artifacts is commonly noticed in **the abdomen, spine and orbits where fat and other tissues from boarders**.



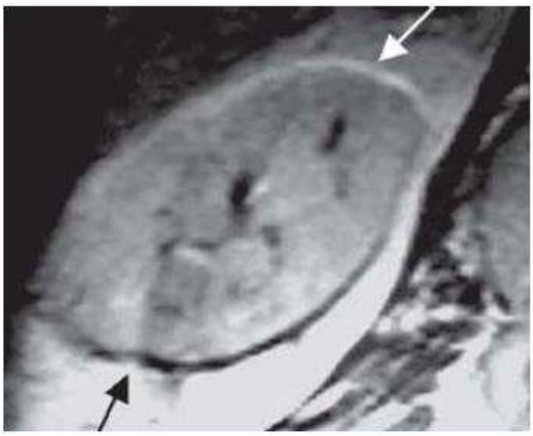


Fig. 7.6: Chemical shift mis-registration artifact water in the kidneys is misregistered along the frequency axis. This causes black signal (arrow) voids at the kidneys left margins and white lines at their right margin (arrow)

This artifact is greater at **higher field strengths** and can be reduced by **increasing the bandwidth**. The only way to eliminate this artifact is to use a **fat suppression technique**.

4-Gibbs or Truncation artifacts:

Gibbs or Truncation artifacts **are bright and dark lines that are seen parallel and adjacent to boarders of abrupt intensity change**, as many be seen at **CSF, spinal cord, fat and muscle**. (fig.5)

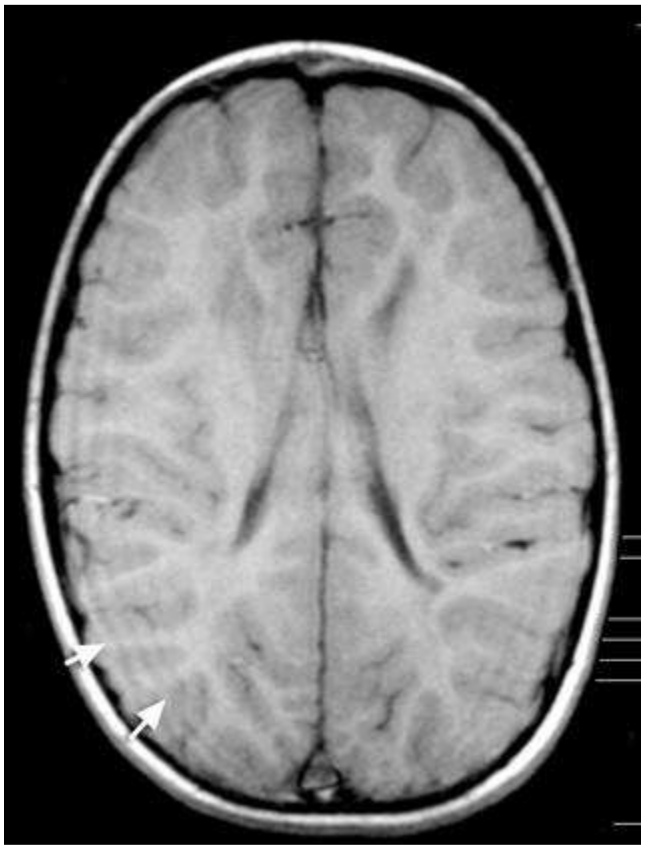
-Axis: Phase encoding direction.

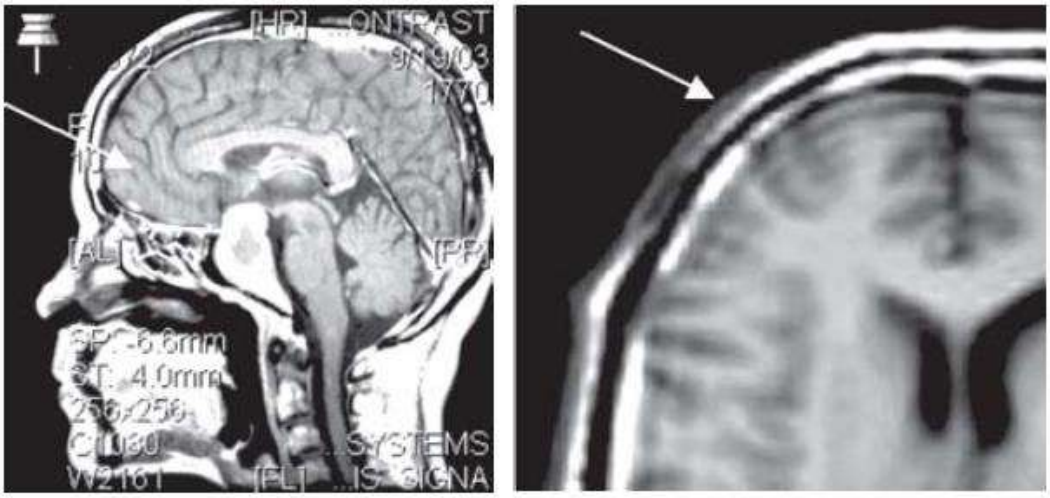
- They can be reduced by

a. Increasing the matrix

b. Using a filter

c. Change the direction of phase and frequency.





Figs 7.7A and B: Low intensity lines appearing near the boundaries of the brain/skull interface, are characteristic of a 160 phase encoding acquisition

Fig 5: Gibbs artifact

5- Point Artifact

Point artifact is seen as a **bright spot of increased signal intensity in the center of the image**. This is caused due to constant offset of DC voltage in the receiver coil which after Fourier transformation appear as a bright spot in the center of the image.

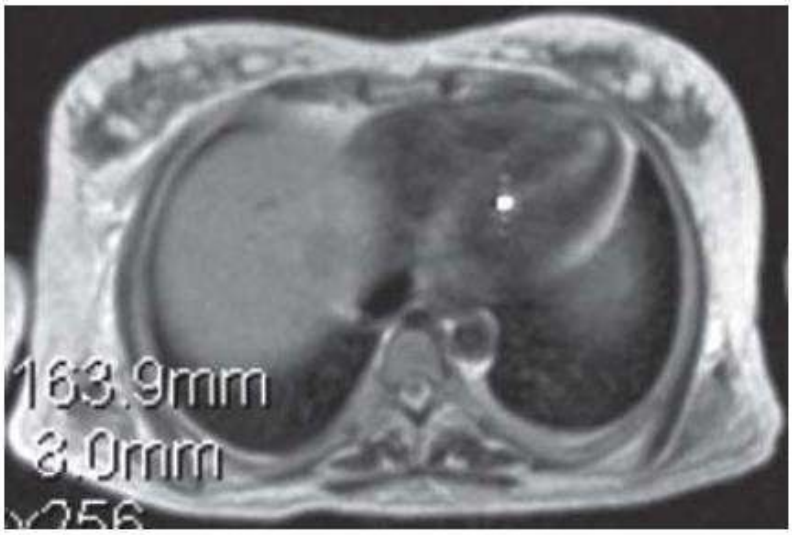
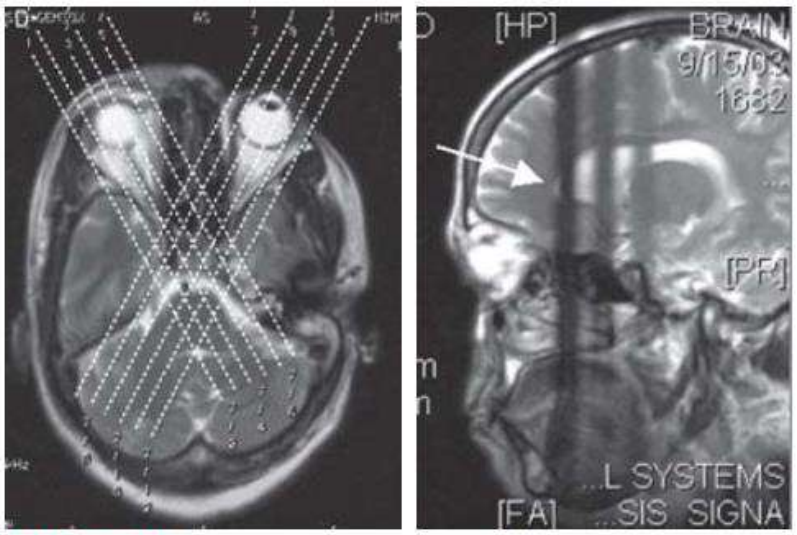


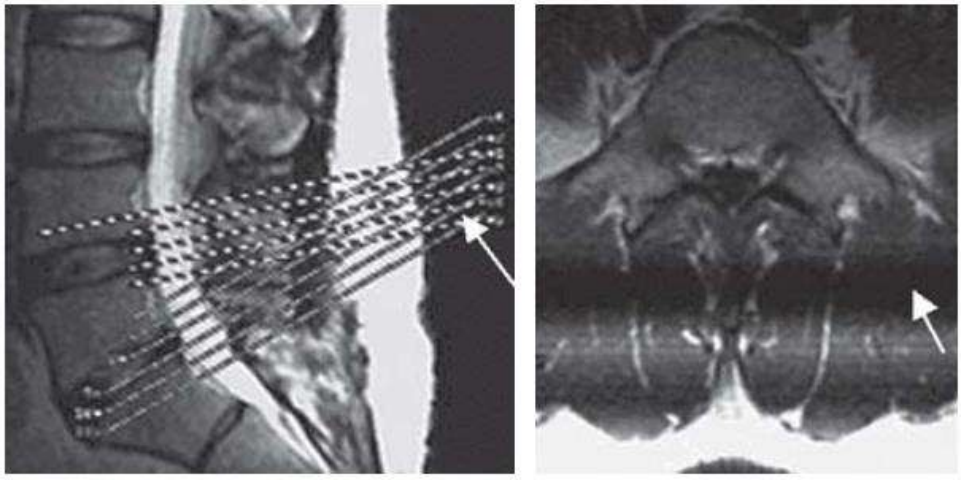
Fig. 7.20: This is an axial image of the cardiac showing a central point artifact

6- Slice Overlap Artifact

The slice overlap artifact is a name **given to the loss of signal seen in an image from a multi-angle, multi-slice acquisitions**, as is obtained commonly in the lumbar spine. If the slices obtained at different disk spaces are not parallel, then the slices may overlap.



Figs 7.21A and B: Para-axials (oblique) T2 weighted images through optic nerves from a multiangle. This causes a band of signal loss crossing vertically in sagittal image



Arrow shows signal loss from overlap

Figs 7.22A and B: This is a para-axial T2 weighted image through L5/S1 from a multiangle, multislice acquisition, as is obtained commonly in the lumbar spine

If two levels are done at the same time, e.g. L4/L5 and L5/S1 then the level acquired second will include spins that have already been saturated. **This causes a band of signal loss crossing horizontally or vertically in our image, usually prominent posteriorly.**

7- Magnetic Susceptibility Artifact:

Magnetic susceptibility is **the ability of a substance to become magnetized**. Some tissues magnetize to different degree than other, resulting into differences in precessional frequency and phase. **This causes dephasing at the interface of these tissues and signal loss.** For example, magnetic susceptibility difference between **soft tissues and air is about 10 ppm.** This causes signal loss and distortion of the boundaries of the brain near air sinuses. Other common causes of magnetic susceptibility artifacts include metal. (fig.6)

-Axis: Frequency encoding and phase encoding.

- **Corrective measures**: Use of **SE sequence and remove the metal.**

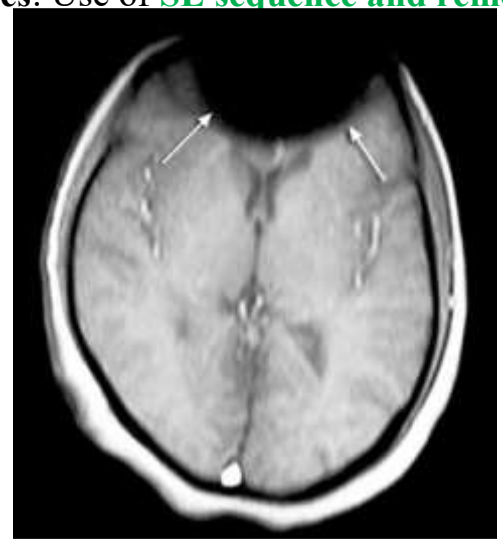


Fig. 6: Susceptibility artifact

8- Zipper Artifacts:

This artifact is caused by external RF entering the room at a certain frequency and interfering with inherently weak signal coming from the patient. There are various causes for zipper artifacts in images. Most of **them are related to hardware or software problems. The zipper artifacts that can be controlled easily are those due to RF entering the scanning room when the door is open during acquisition of images**. RF from radio transmitters will cause zipper artifacts that are oriented perpendicular to the frequency axis of the image. Fig.7

-Axis: Perpendicular to the frequency axis of the image.

-Corrective measures: System generated artifacts should be reported service engineer.

Fig 7: Zipper artifact