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Magnetic resonance imaging (MRI) Raw Data Results and Its Diagnosis of Spinal Cord Injuries: Patient Case

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ABSTRACT

In the present study, we discussed the best techniques for the clear scan of the spine. For this investigation, it was found that magnetic resonance imaging (MRI) is a better technique as compared to others. It gives proper images and results in the case of hard tissues like the spine compared to X-Ray and computed tomography (CT) scans. It is also better in sense of it has a small radiation risk as compared to X-Ray and CT have some radiation hazards to patient health. Thirteen patients were scanned by MRI technique and the result was evaluated. It is a non-invasive technique and is used for different pathological diseases. It was found that most doctors and surgeons preferred the MRI techniques in the case of the Spinal Cord. Many radiologists exercised X-rays, CT, and MRI methods for viewing clear images of the spine. It was concluded that MRI is the best technique than X-rays and CT scans. MRI is a modality choice for the evaluation of soft tissue changes in the case of Cord. In the case of the Spinal Cord MRI better evaluates changes in spinal cord compression due to its high-resolution property. The CT could not tell us about the soft tissue change in Cord however it more clearly tells us about the fracture of vertebral bodies and posterior elements.

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1. INTRODUCTION

Mostly our body is made of small particles called atoms and water molecules. The protons continuously spin in any directions which are present inside the atom and the molecules of water consist of hydrogen nuclei. When the body is positioned in a strong magnetic field of scanner and the photons of the body align in directions of the magnetic field, the signals of a radio frequency are sent into a magnetic field. The signal bends the protons' path sending out of the arrangement and making the signal off and the protons return to their arrangement and emit energy. The energy emitted by the twisted protons is calculated by an aerial coil and comes back to their organized place. This information explains the different forms of tissues and protons' position and their phase (Velthuizen *et al*., 1998).

Rotating motion of the certain types of nuclei that are present in biological organs are used in magnetic resonance imaging (MRI). These are called magnetic resonance (MR) active cores. The nuclei having an odd number of protons having total magnetic moment due to rules of quantum mechanics only may interact with the exterior magnetic field. MR strong cores of the hydrogen nuclei which are used in MRI (see **Figure 1**).

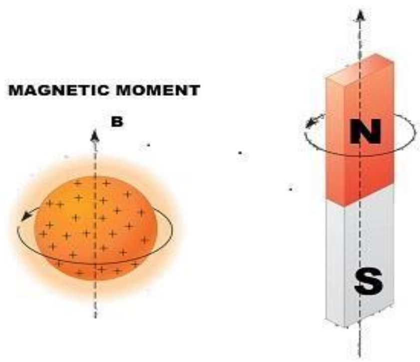

Figure 1 Spinning of Hydrogen Nuclei.

Due to these spinning properties of protons, a strong external magnetic field induces. This induced field has two possible conditions. It should be either parallel or anti-parallel to the direction of the applied magnetic field (Velthuizen *et al*., 1998).

Further, the arrangement with B0, at a suitable frequency proton will interrelate. The Larmor equation explains the frequency of interacting protons. Lamour equation is the product of the external static magnetic field and the gyromagnetic ratio that will be equal to Larmor frequency. An increase in B0 raises the processional frequency and a decrease in B0 lowers the processional frequency. This equals to spinning top, due to gravitational force. The top will be slower due to strong gravitation. Adjusting protons in a magnetic field, a few of them arranged anti-parallel and a few of them arranged parallel. The alignment is in a parallel direction at low energy values. The antiparallel alignment will appear at high energy values.

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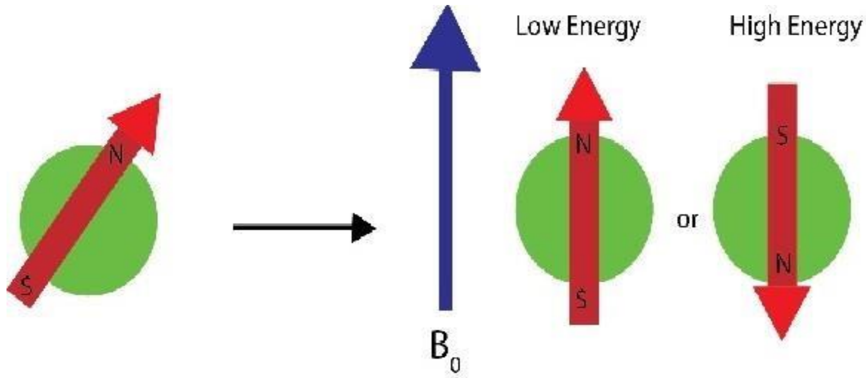

Figure 2 Energy States of Proton.

The strength of applied external magnetic field B0 affects the difference between energy states having high and low values (Cavezian *et al.*, 1986). The difference between the two spin states will be large as the strength on the exterior applied magnetic field is large. We use this procedure to make images by using magnetic resonance. Only one proton is present in the hydrogen nucleus and represents a certain magnetic moment. A large quantity of hydrogen is present in the human body. The body tissues are magnetized by setting it in the MR imaging process if the body is adjusted in a strong external magnetic field (Chrysikopoulos 2009).

MRI machines have a large number of models in the market but all have working principles and basic parts are the same. A large cylindrical pipe that is surrounded by a circular magnet is a conventional MRI Unit.

The body will adjust on a moveable testbed which is adjusted at the axis of the magnet. Some units of MRI are very small-bore system is made and the body is not surrounded by the magnet and sides are open. For testing the horrified patients these open test MRI units prove very helpful. Very clean images of different types of tests are made by open MRI units but older open MRIs with older magnets are not able to give the same quality. An open MRI cannot be used for typical tests (Bracoud, L., *et al*., 2011).

MRI technology is different than x-ray and computed tomography (CT) scanners. MRI does not use ionizing radiation but computed tomography depends on ionizing radiation. MRI uses magnetic properties of spinning proton which is nuclei of the hydrogen atom, radio waves, and strong magnetic field. When an electric current pass through the conducting coil of the MRI unit the magnetic field is produced. Other helping coils, located in the machine or placed around the part of the body to be imaged. Sends and receives radio waves, producing signals that are detected by the coils. The signals are processed and images series are produced by the computer each of which represents the small patch of the body. The images may be observed in multiple directions by the observer.

The doctors use recent MRI technology for representing the image of internal tissues of the body. MRI is a radiological practice that uses radio signals, magnetism, and a computer. The MRI scanner is a pipe that is enclosed by a large round magnet there is a table on which the patient is positioned that is surrounded by various helixes that can produce a strong constant magnetic field. The certain atoms in the patient to vibrate are generated by a system using radio frequency (RF) signals. The atoms vibrate continuously for a short time if the RF signals are escaped. Usually, the doctors observe the oscillating atoms in MRI. The computer processes the signal and changes these into a clear image of the body. The body radiates the signals which are generated by the protons present in the body. Signals of the hydrogen atoms that are part of the body are used in certain MRI scanning.

By the gathering of protons in a given tissue the first magnetic resonance images were not clear and did not represent good results. The time is taken by the protons to emit their signals

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is called rest time and was participated in measuring the scan. To make an interior image of the body the MRI technology is very important. Two rest times are considered in the complete body tissues that are represented by T1 and T2. The difference between T1 and T2 is displayed by different types of tissues. The T1 and T2 values of the brain are different than blood tissues. A distinct image can be obtained by three variables, proton density, T1, and T2 values. The different protons of the body are rotated by these three variables and they produced unclear signals which are observed at the receiver of the MRI scanner. The computer organizes the receiver detail and makes the image. MRI briefs the images and designs completely and produces the small oscillations in the body. In some technologies, separate agents for example gadolinium increase the strength of the images (Collett *et al*., 1998).

Spinal line damage (STI) means a decent number of physically and rationally stunning lines that an individual can endure. This kind of harm regularly aftermath in a lifetime reasonable handicap for some time ago solid people. In the Netherlands, about 100-200 people are misrepresented by cordtic SCI (tSTI). Among the current crisis restorative administrations, careful measures, enhanced vocation conditions, and administrations, anti-infection agents the life expectancy of individuals with SCI has expanded over years and is being foreseen to lift sooner rather than later. Once damage of the youthful age just as rising old individuals has distorted the study of disease transmission of tSTI, amid the typical time of SCI people going up from 30 years in the mid-1970s to 35 years in 2005. At each age, SCI has an enormous effect, not just on an individual dimension; it has likewise for a whole society as for the cost of intense and steady consideration (James & Dasarathy, 2014).

The seriousness of most critical wounds to Spinal string is fundamental for the achievement of neuro defensive intercessions. The power of essential cordtic stun to the Spinal line is straightforwardly associated with Spinal string harm. A stun to Spinal string can cause extreme physical wounds with neurological putrefaction. It is likewise the reason for axonal crumbling and extra degeneration or loss of neuron cells by apoptosis or putrefaction forms A, which can last from days to weeks.14 accessible neuro defensive disclosures all intend to take a postponement and additionally keep the auxiliary damage. It is additionally accepted that patients in the organization of increasingly thorough SCI respond distinctively to neuroprotective impedance than that of less thorough SCI. precise and early examination of the seriousness of the Spinal rope wounds is basic for new neuro defensive intercessions. Recognizable proof of meticulousness of the Spinal line damage can be decided with the International Standards for Neurological Classification of Spinal string Injury. This neurological investigation as indicated by American Spinal Injury Association (ASIA) scores,15 is thought to be unfailing and extrapolative in patients when they tried 70 hours after the primer cord.16 Within 70 hours post damage various components like spinal surprise, medicinal instability, partnered mind wounds or unconsciousness can influence the validity of the neurological examinations. In the perspective of neuro defensive mediations like serious Spinal line decompression or adjustment must be done within 24 hours post damage, the limitations of the neurological examinations turn out to be clear. Even though in the eccentrics in indiscreet neurological enhancement is generally high, making it necessary to enroll vast insights of patients to accomplish the adequate capacity to see clinically huge contrasts in function. As an image of this, the post-hoc inquire about investigations of the flightiness in unprompted neurologic enhancement in the Sygen multicenter uncovered that to see a 5 qualification in engine score in patients with a flat out cervical Spinal line damage, one would need to enlist roughly 38o patients18, and assume that was not achieved in 5 years of the Sygen multicenter trials.19 Evidently, the dependence of restorative preliminaries on useful neurologic measurements to enroll patients and afterward comprehend the viability of the intruding is a

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principle impediment in light of two critical issues the inadequacy to perform such strategies reliably in numerous patients inside 24 hours post wounds and the irregularity in unstructured enhancement in those patients in whom such neurological dealings can be procured (Velthuizen *et al*., 1998).

Future quantifiable research in the field of drug purposes will likewise need to stratify and compel tests for increasingly responsive identification of taking care of impacts. In this discernment, a few SCI harms are considered with various elements from other non-syndromic SCIs. Disregarding the distinctive applications, the value of disorder classification is directly constrained by factor meanings of disorders and by the intricacy of actualizing for the separating disorders. Moreover, patients with SCI disorders are in some cases rejected while they are accepted to have a more positive result than non-SCI disorder patients. To illustrate, the overall board of SCI pros gathered by the International Campaign for Cures of Spinal rope Injury Paralysis, achieved that cordtic focal string patients may be stratified contrastingly in clinical preliminaries, as the unordinary enhancement model could support up the capriciousness of the completion information (Cavezian *et al*., 1986).

In the present study, we discussed the best techniques for the clear scan of the spine. For this investigation, it was found that MRI is a better technique as compared to others. Because it gives proper images and results in the case of hard tissues like the spine compared to X-Ray and CT scans. It is also better in sense of it has a small radiation risk as compared to X-Ray and CT have some radiation hazards to patient health. Thirteen patients were scanned by MRI technique and the result was evaluated. It is a non-invasive technique and is used for different pathological diseases. It was found that most doctors and surgeons preferred the MRI technique in the case of the Spinal Cord. Many radiologists exercised X-rays, CT, and MRI methods for viewing clear images of the spine. It was concluded that MRI is the best technique than X-rays and CT scans. MRI is a modality choice for the evaluation of soft tissue changes in the case of Cord. In the case of the Spinal Cord MRI better evaluates changes in spinal cord compression due to its high-resolution property. The CT could not tell us about the soft tissue change in Cord however it more clearly tells us about the fracture of vertebral bodies and posterior elements

2. METHODS AND MATERIALS

In the present study, patients were discussed (n=13) by the MRI technique. Their scans were taken from BVH, the Radiology department. The MRI machine which was used for this purpose was Philips 1.5 T MRI machine. The study was conducted on patients with spinal cord injury they were scanned by MRI imaging and injuries were recognized by the scanning. The reports of injured patients collected and prominent cases were discussed in the result section.

2.1. Study Area

The study was conducted in the Bahawal Victoria Hospital Bahawalpur district Bahawalpur.

2.2. Demography of Patients

The patients belong to different backgrounds, gender, and age groups. There was no targeted population. They have common that they have all injured in the spine.

2.3. Working of Philips MRI Machine

The process adopted for research work explains MRI device its working and physics for the production of MRI imaging.

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p- ISSN 2775-6793 e- ISSN 2775-6815

(i) The machine of MR imaging consists of parts that are given below, a strong field producing magnet is used to create a high magnetic field.
(ii) Gradient system that consists of coils, these coils generate linear field deformation in the direction of x, y, and z directions.
(iii) Radio Wave Frequency is introduced in the scanner along with the coil.
(iv) Radio Frequency Receiver is a single coil used for picking and amplifying the generated low MR signals of the image.
(v) Additional coils are also required for receiving and transmitting the MR signals.
(vi) Different computers are also used for gradient and scanner observations, the formation of MR images, and coordinating all processes.
(vii) Peripheral instruments are the part of the MRI machine that controls the table of the patient. The triggering of MR Sequence includes respiration monitors and ECG equipment. This also includes the second operator’s console and picture achieving and communications system.

3. RESULTS

These images are taken from the laboratory in which the MRI machine is functional. That system uses a magnetic field of 1.5T. That system was made by the PHILIPS model.

Figure 3 shows Case No. 1 for a 45-year male patient. In the patient report, it was taken IV Contrast. There is a fracture of body of C6 vertebral body causing compression of the spinal cord at this level.

Figure 4 shows Case No. 02 for a 60-year male patient. In the patient report, it was taken IV Contrast. An interior displacement of C5 over C7 vertebral body with fracture of C6 causing cord compression.

Figure 5 shows case no. 3 for a 50-year male patient. In the patient report, it was taken IV Contrast. An interior displacement of C5 vertebral over C6 vertebral body with partial collapse of C5 causing cord contusion at this level.

Figure 6 shows case no. 4 for a 51-year male patient. In the patient report, it was taken IV Contrast. There is burst fracture of L3 vertebral body with surrounding hematomas rest of the visualized vertebral body appears normal.

Figure 7 shows case no. 5 for a 52-year male patient. In the patient report, it was taken IV Contrast. An anterolateral subluxation of T6 over T7 vertebral body with complete cut off the spinal cord at this level.

Figure 8 shows case no. 6 for a 60-year male patient. In the patient report, it was taken IV Contrast. A hyperintense focus on T2 weighted images in this spinal cord at the level of C3/C4 level suggestive of spinal cord contusion.

Figure 9 shows case no. 7 for a 47-year female patient. In the patient report, it was taken IV Contrast. There is a fracture line visible in the body of the C5 vertebral body with retropulsion of the body causing compression of the spinal cord at this level. There is a small hematoma interior to this spinal cord at this level. There is a soft tissue hematoma extending up to the C2 vertebral body.

Figure 10 shows case no. 8 for a 50-year male patient. In the patient report, it was taken IV Contrast. There is gross retropulsion of the C7 lower cervical vertebra causing compression of the spinal cord at this level. There is a hematoma interior to the body of the above vertebra.

Figure 11 shows case no. 9 for a 458-year male patient. In the patient report, it was taken IV Contrast. A partial collapse and fracture of the C6 vertebral body with retropulsion of the C6 vertebra causing compression of the cord at that level. Abnormal high signals in the cord are suggestive of cord contusion at that level.

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Figure 3 Vertebral body of spinal cord.

Figure 4 Error! No text of specified style in document. C_5/c_7 vertebral body of the spine.

Case No. 03

Age 50 years Gender Male

Figure 5 Collapse of c_5 vertebral cord contusion.

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p- ISSN 2775-6793 e- ISSN 2775-6815

Figure 6 l3 vertebral body.

Figure 7 A cut of the spinal cord at T6/T7.

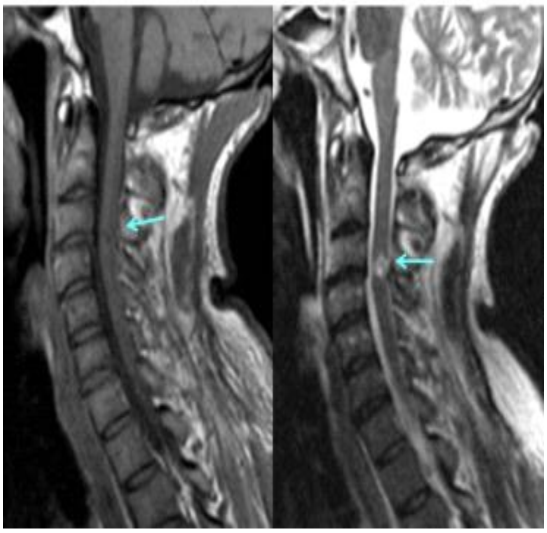

Figure 8 T2 weighted image of the spinal cord.

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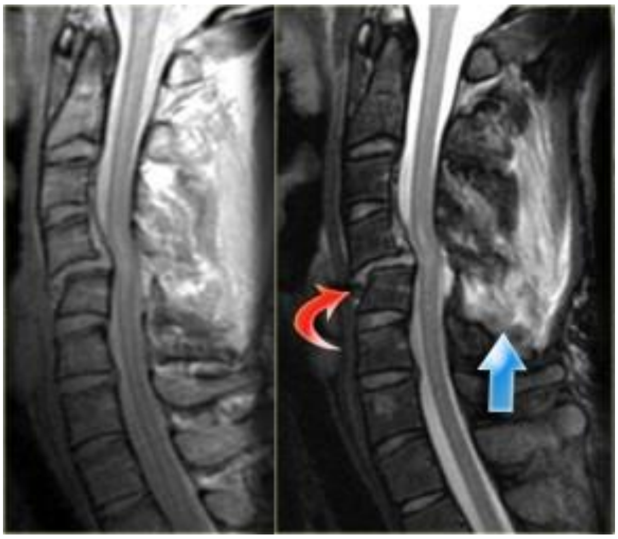

Figure 9 Retropulsion of spinal cord.

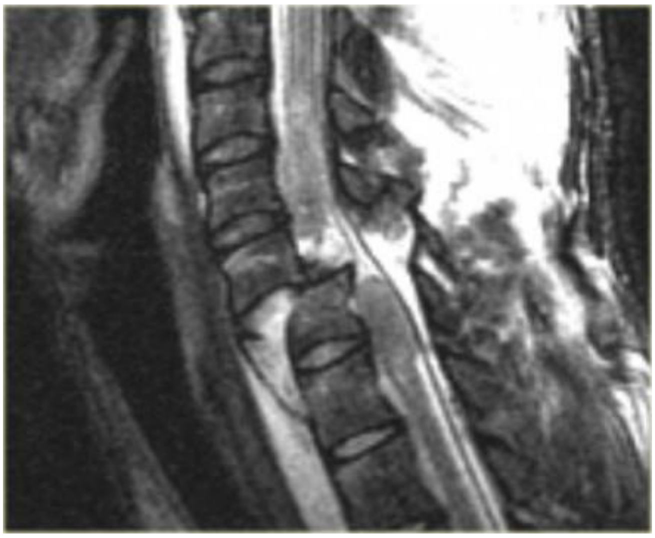

Figure 10 Gross retropulsion of spinal cord vertebra.

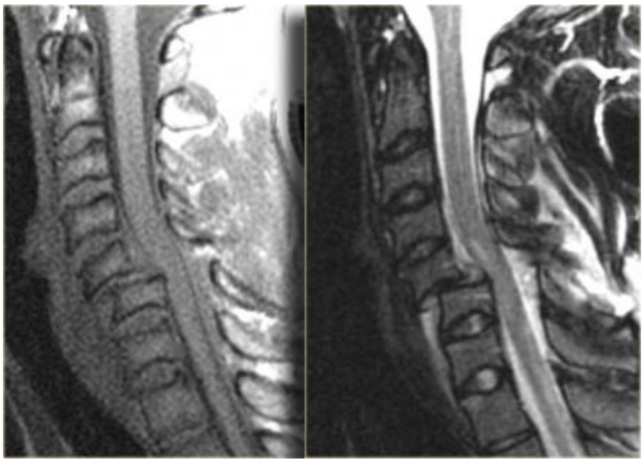

Figure 11 Collapse and fracture in the spinal cord.

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Figure 12 shows case no. 10 for a 42-year male patient. In the patient report, it was taken IV Contrast. There is cord compression due to disc osteophyte complexes at C4.C5 and C5, C6 vertebral body. is also causing the spinal cord at the level. However, no fracture is visible.

Figure 13 shows case no. 11 for a 38-year female patient. In the patient report, it was taken IV Contrast. The fracture in fragmentation of C5 vertebral body with retropulsion causing mild cord compression abnormal high signals in the cord is suggestive of cord contusion at the level.

Figure 14 shows case no. 12 for a 48-year male patient. In the patient report, it was taken IV Contrast. Destruction and fragmentation of C5 vertebral body causing cord compression at that level abnormal signals in the cord are suggestive of cord contusion.

Figure 15 shows case no. 13 for a 45-year female patient. In the patient report, it was taken IV Contrast. Fracture of the body of C6 vertebral body with abnormal high signal in the cord is suggestive of cord contusion at that level.

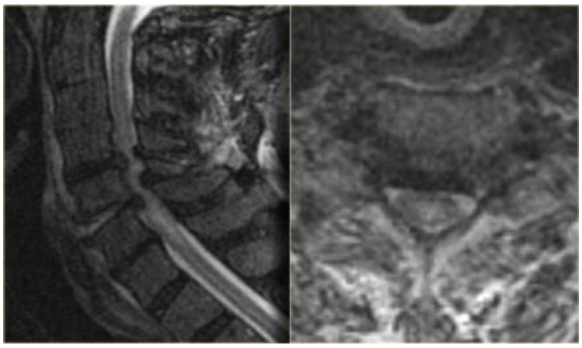

Figure 12 Cord compression due to osteophytes.

Figure 13 In the fragmentation of the C5 vertebral body.

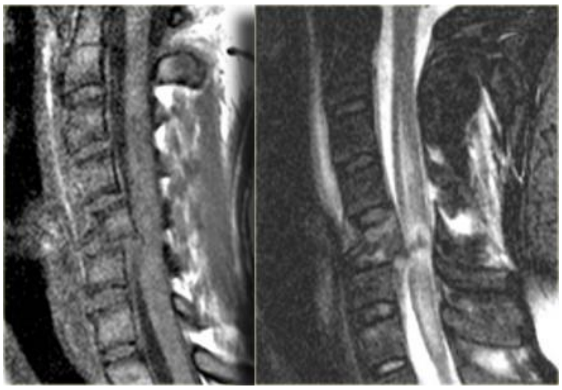

Figure 14 Destruction and fragmentation in the cord.

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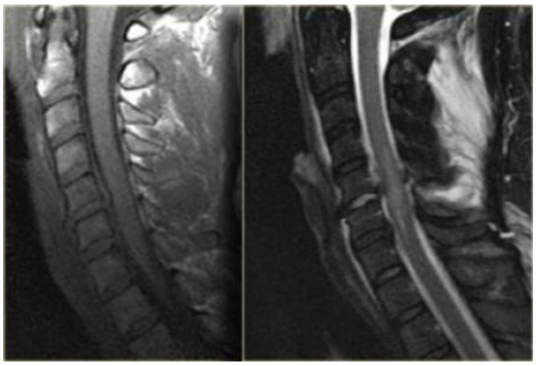

Figure 15 Fracture of C_6 vertebral body.

4. DISCUSSION

In this work, data of spinal cord injuries was collected from “Bahawal Victoria Hospital Bahawalpur”. All type’s diseases of the spinal cord were reported in the data in which cord compress and fractures including C1, C2, C3, C4, C5, C6, or C7 vertebral. It is examined that there were thirteen cases out of which ten are male patients and three were female patients. Patients’ ages were among 38 years to 60 years. Thirteen cases data is represented in tabular form in which C1 to C7 vertebral shown containing compression and features in spinal cords as follow (see **Table 1**):

Table 1. Containing compression and features in spinal cords.

Case	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Result
1						✓					Compression in C6 vertebral
2					✓	✓	✓				Displacement in C5 and C7 and Compression in C6
3					✓	✓					Displacement of C5 over C6
4			✓								Burst fracture in L3
5						✓	✓				Antero-lateral of L6 over L7
6			✓	✓							C3, C4 spinal cord contusion
7		✓			✓		✓				Compression in C2C3C7
8								✓			Retropulsion of C7
9						✓					C6 spinal cord contusion
10				✓	✓	✓					Compression in C4C6
11					✓						Compression in C5
12					✓						Compression in C5
13						✓					Fractures in C6

5. CONCLUSION

MRI is the most accepted diagnosis of diseases by imaging process. We can see the internal structure of human anatomy by MRI. It provides quick and precise details about spinal cord injuries especially compression in the cord. MRI is also sustaining for assessment of “Hematoma”. Contrast MRI provides enhanced imaging outcomes than plane MRI. MRI has numerous benefits and drawbacks. High radiation dose absorption is the main disadvantage. Multi-planner images may help assess spinal cord injuries with surrounding organs imaging. In conclusion, MRI is a “nonsurgical” technique that helps us with the “pathological” and “medical” clarification of bugs in the human being body.

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In this work of spinal cord had explained a few methods for some patients and then compare these methods with each other. Many radiologists exercised x-rays, CT, and MRI methods for viewing clear images of the spine. For this work, we concluded that MRI is the best technique than x-rays and CT scans. Now a day it is also used for brain diseases.

MRI is a modality choice for the evaluation of soft tissue changes in the case of Cord. In the case of the Spinal Cord MRI better evaluates changes in spinal cord compression due to its high-resolution performance. The CT could not tell us about the soft tissue change in Cord however it more clearly tells us about the fracture of vertebral bodies and posterior elements. MRI more clearly defines the extramural/subdural hematomas and spinal cord compression and contusion. Due to its multi sequential properties, it could tell us about the ages of extramural/subdural hematomas. It can differentiate between infection and cord of spinal. I could differentiate between the cord and malignant processes of the spine and spinal cord. In this work, all cases use IV contrast because it gives a better image of the spinal cord than non-contrast, also 9 samples (cases) have a medical condition from C6 and C5 vertebral, 2 samples were by T1, T2 and 1 case contain C3 vertebral. Hence it is concluded that hematoma and cord compression in diverse plexus like lumber and cervical at numerous locations and injuries in the spinal cord are in majority, also C6 and C5 vertebral are in majority.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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