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Role of MRI Diffusion Tensor Imaging in the Assessment of Traumatic Spinal Cord Injuries.

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Abstract

Introduction: Traumatic spinal cord injury (SCI) is a severe condition that significantly affects a patient's physical, psychological, and social well-being. According to estimates, there are 11 to 53 new instances of SCI for every million people. **Objective:** This paper aims to assess the role of MRI diffusion tensor imaging in the assessment of traumatic spinal cord injuries. **Patients and Methods:** In this study has focused on the assessment of Traumatic Spinal Cord Injuries and the role of MRI Diffusion Tensor Imaging where data were collected retrospectively through reviews of electronic medical records or electronic hospital records, and discharge data for all traumatic Spinal Cord Injured patients different hospitals in Iraq between 6th June 2021 to 12th October 2022, who were >30 years of age or older. A statistical study was conducted for traumatic Spinal Cord Injured patients using the SPSS program. Data were collected from different hospitals in Iraq for patients in general, where the groups were divided into two groups, one of which represented a group of traumatic spinal cord Injured patients, which recruited 30 patients, while the second group was Control patients, which recruited 20 patients. **Results and Discussions:** This study focused on MRI which is considered widely used in the diagnosis of traumatic SCI. According to pathological findings related to the mechanism of injury, this study found falling got the higher number of cases of patients in the mechanism injury where it got 13 (43.33%) while the heavy attack was the lowest where got 6 (20%). Based on the AIS grades, Falling have A — A Car accident, A — C, and Heavy attack A — D. Although, the French study mentioned that the FA value at the site of injury have the highest cases of patents. However, our study found that the FA value above got more cases in comparison with the control group. In the assessment of the quality of life of traumatic spinal cord injuries patients, the physical side had the biggest effect on the patients where the patients group had 64.88 ± 2.13 while the control group have 77.45 ± 1.36 with a p-value of 0.0435. **Conclusion:** In conclusion, higher FA levels imply the integrity of the spinal nerves since they directly reflect the degree of myelination. By comparing our patients to controls, no discernible difference was found in the mean FA levels at or below the damage threshold. Also, the quality of life of patients found that all four parameters got higher evaluation in the control group in comparison to the patient group.

Keywords: FA; Traumatic spinal cord injury (SCI); MRI Diffusion Tensor Imaging; and Admission-operation time.

Introduction

Traumatic spinal cord injury (SCI) is a severe condition that significantly affects a patient's physical, psychological, and social well-being. According to estimates, there are 11 to 53 new instances of SCI for

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every million people [1]. According to 1980s epidemiological data, young adults are the main demographic affected by spinal cord injury (SCI) (mean age: 29 years). However, the percentage of older SCI participants has significantly grown during the past three decades where the average age of injury at the moment is thought to be 45. Incomplete tetraplegia was the most prevalent kind of paralysis across all age categories, followed by total paraplegia (25.6%), complete tetraplegia (20.4%), and incomplete paraplegia (18.5%). [2] Despite the lack of treatment, the care of SCI patients has advanced significantly in the twenty-first century [3]. Following the discovery and use of antibiotics, the prevention of complications, and the introduction of specialized care by the founding fathers of SCI rehabilitation, Dr. Donald Munro, and Sir Ludwig Guttmann [4], survival rates in the SCI community grew considerably.

Traumatic spinal cord injuries may often be diagnosed via magnetic resonance imaging (MRI) (SCI) [5]. In the spinal cord, macroscopic pathological alterations such as intramedullary edema or intramedullary bleeding are primarily reflected by conventional MRI, as well as the rate of spinal cord compression [6]. The association between the rate of spinal cord compression in a conventional MRI and the patient's neurological results was the topic of a study on thoracolumbar SCI. Nevertheless, there are currently limited clinical investigations of diffusion tensor imaging (DTI) on thoracolumbar SCI, particularly acute SCI, and the association between DTI parameters, including partial variance (FA) and apparent diffusion coefficient (ADC). [7]
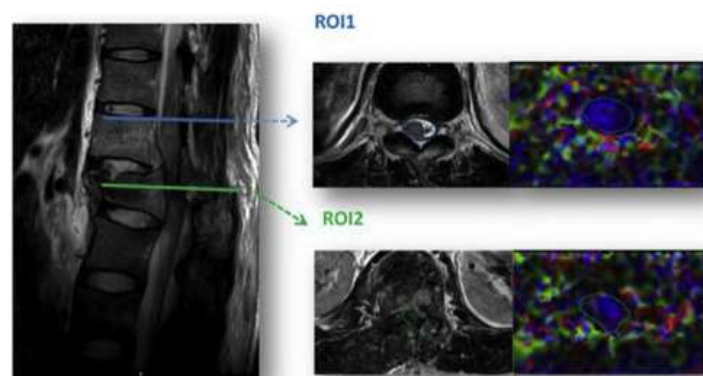

Figure A- Spinal cord diffusion tensor imaging parameter detection method

There hasn't been any research on the association between patient prognosis and the quantity of fictitious white matter fibers discovered by diffusion tensor imaging (DTT) [8]. To assess the severity and prognosis of SCI, quantitative MRI techniques like DTI may detect the movement of water molecules in spinal cord axons to reveal microscopic degenerative alterations. The neurological prognosis of patients with cervical SCI or cervical spondylopathy has been linked to DTI metrics including FA and ADC values, according to a number of studies. [9]

In a prior study, we discovered that several patients with acute SCI upon admission who had an improvement in their AIS score at the last follow-up still had some white matter fibers present, as determined by DTT [9,10]. Yet, most grade an AIS patients who did not recover revealed complete rupture of white matter fibers [11]. Therefore, the study measured FA value, ADC value imaginary white matter fiber volume (IWMFV), and communication fibrin imaging rates (CRFT) in 20 cases with complete thoracolumbar SCI and analyzed the relationship between these parameters and neurological outcomes to investigate the presence of this phenomenon in patients with thoracic SCI and to evaluate the role of DTI and DTT in the diagnosis of thoracic and lumbar SCI. [12,13]

The following factors are crucial after a patient with TSCI's first medical stabilization: (1) maintaining mean blood pressure over 90 mm Hg with intrusive monitoring and hemodynamic support, (2) avoiding problems, and (3) reliably forecasting long-term results [14]. Patients and their families want to know if they will be able to walk again and whether they will be able to undertake self-care tasks like eating, bathing, and dressing in the early stages of the injury [15]. This paper aims to assess the role of MRI diffusion tensor imaging in the assessment of traumatic spinal cord injuries.

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Patients and Methods

In this study has focused on the assessment of Traumatic Spinal Cord Injuries and the role of MRI Diffusion Tensor Imaging where data were collected retrospectively through reviews of electronic medical records or electronic hospital records, and discharge data for all traumatic Spinal Cord Injured patients from different hospitals in Iraq between 6th June 2021 to 12th October 2022, who were >30 years of age or older. These data were designed with two groups where the first group was represented with traumatic Spinal Cord Injured patients that explain the patients have traumatic Spinal Cord Injuries while the second group was represented a control group that explain the patients' group who could treated of it. A statistical study was conducted for traumatic Spinal Cord Injured patients using the SPSS program. In this study has focused on the assessment of Traumatic Spinal Cord Injuries and the role of MRI Diffusion Tensor Imaging where data were collected retrospectively through reviews of electronic medical records or electronic hospital records, and discharge data for all traumatic Spinal Cord Injured patients from different hospitals in Iraq between 6th June 2021 to 12th October 2022, who were >30 years of age or older. These data were designed with two groups where the first group was represented with traumatic Spinal Cord Injured patients that explain the patients have traumatic Spinal Cord Injuries while the second group was represented a control group that explain the patients' group who could treated of it. A statistical study was conducted for traumatic spinal Cord Injured patients using the SPSS program. Data were collected in different hospitals in Iraq for patients in general, where the groups were divided into two groups, one of which represented a group of traumatic spinal cord Injured patients, which recruited 30 patients, while the second group was Control patients, which recruited 20 patients, where the comprehensive information for traumatic spinal cord Injured patients were distributed on the males and females. This study presented the distribution of patients according to age then it focused on patients who have traumatic Spinal Cord Injured which can be seen in **Figure 1**. To a follow-up, this study was shown the distribution of patients according to sex which was conducted on the traumatic spinal cord Injured patients within males and females which can represented on **Figure 2**. Also, this study was extended to the Distribution of patients according to BMI where had three divisions the first (25-28.5), second (29-32.5), and third (33-36.5) can be shown in **Figure 3**. Furthermore, this study assessed pathological findings related to the mechanism of injury where parameters had falling, car accident, and heavy attack can be seen in **Table 1**. Besides to mechanism injury, this study was evaluated traumatic spinal cord Injured patients based on AIS grades which AIS grades divided into three sections into A-A, A-C, and A-D which found all these details in **Table 2**. According to FA, this study was conducted into a comparison of FA between the patients' group and control groups which included the FA value above, FA value at the site of injury, and FA value below, and all details were shown below in **Table 3**. In this study, the data was doing a Comparison of Age, Admission-operation time, and Follow-up time between the patients' group and control group which found age, admission-operation time, and follow-up time can be seen in **Table 4**. As well as this study the quality of life of traumatic spinal cord injuries patients through the determination of four parameters which include fear, depression, anxiety, and physical side which noticed all these in **Table 5.**
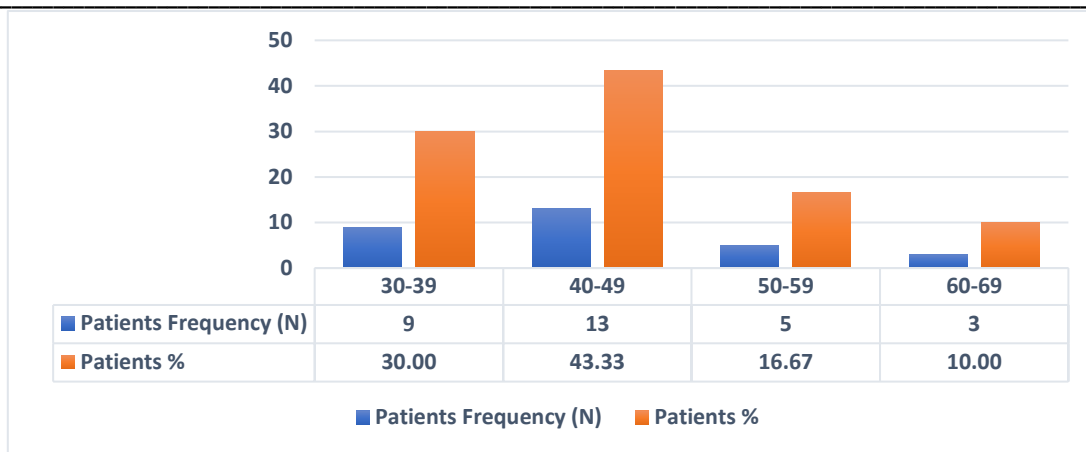
Results

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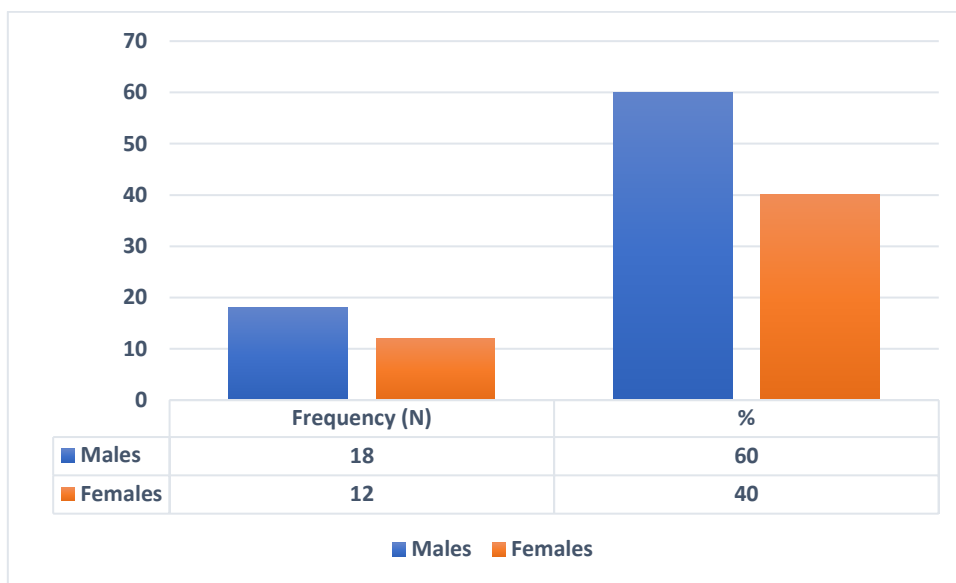**Figure 1:** Distribution of patients according to Age.

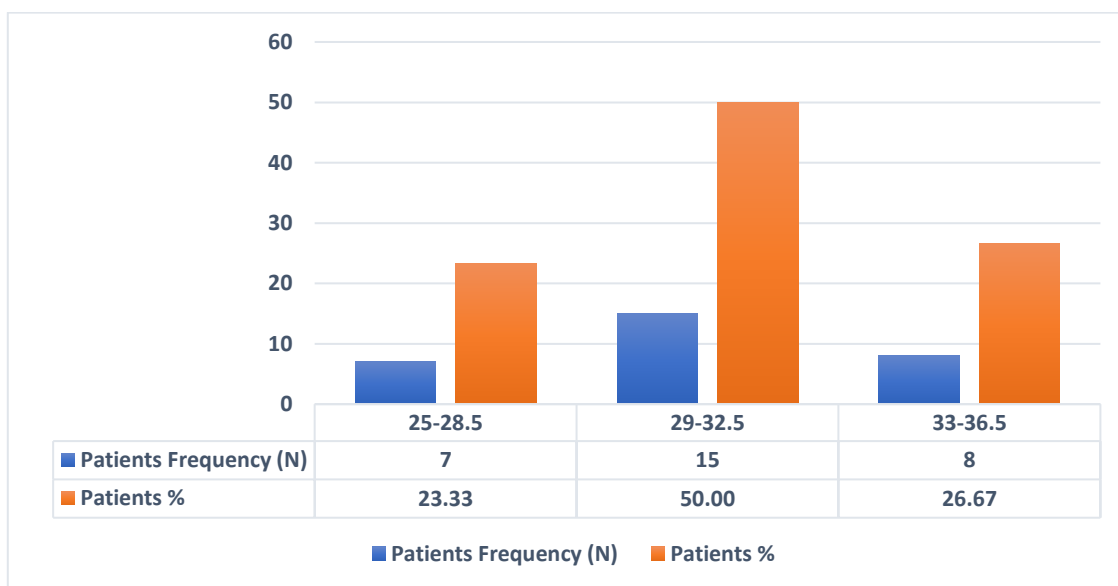**Figure 2-** Distribution of patients according to Sex.

Figure 3- Distribution of patients according to BMI.

Table 1: Pathological findings related to the mechanism of injury.

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Mechanism Injury	Outcomes of Patients	
Items	*N*	*%*
Falling	13	43.33
Car Accident	11	36.67
Heavy attack	6	20.00

Table 2: Evaluation of patients based on AIS grades.

Mechanism Injury	Outcomes of Patients	
Items	**N**	**AIS Grades**
Falling	13	A — A
Car Accident	11	A — C
Heavy attack	6	That

Table 3: A comparison of FA between the patients' group and control groups.

Variables	Patients Group (N=30)	Control Group (N=22)	P-value
FA value above			
Mean ± SD	0.531 ± 0.105	0.534 ± 0.076	0.0495
FA value at the site of injury			
Mean ± SD	0.341 ± 0.132	0.534 ± 0.077	0.0436
FA value below			

| Mean ± SD | 0.436 ± 0.162 | 0.534 ± 0.076 | 0.04833 |

Table 4: Comparison of Age, Admission-operation time, and Follow-up time between the patients' group and control group.

Variables	Patients Group (N=30)	Control Group (N=22)	P-value
Age			
Mean ± SD	47.00 ± 5.9	46.70 ± 5.6	0.04842
Admission-operation time			
Mean ± SD	34.25 ± 5.253	27.72 ± 5.052	0.04237
Follow-up time			
Mean ± SD	19.66 ± 0.260	18.42 ± 1.577	0.04873

Table 5: Assessment of quality life of traumatic spinal cord injuries patients.

Variables	Patients Group (N=30)	Control Group (N=22)	P-value
Depression	60 ± 5.24	72.44 ± 4.27	0.0424
Anxiety	54.4 ± 8.77	74.21 ± 0.63	0.0422
Physical side	64.88± 2.13	77.45 ± 1.36	0.0435
The fear	62.32 ± 3.37	76.58 ± 1.64	0.04134

Table 6- Outcomes of ADC value of group patients and control

Variables	Patients Group (N=30)	Control Group (N=22)	P value
above	**1.92±0.69**	**1.80±0.88**	**0.01**
at the site of injury	**1.299±0.345**	1.80±0.88	**<0.001**
below	**1.882±0.77**	1.80±0.88	**<0.001**

Discussion

This study presented traumatic spinal Cord Injured patients which have 30 cases of patients in comparison with the control group. This study focused on MRI which is considered widely used in the diagnosis of traumatic SCI [16]. To follow that, this study was shown patients with ages (30-39), (40-49), (50-59), and (60-69) where it found the ages 40-49 were the got the highest of patients where 13 (43.33%), as well as this study, was noticed that males have more cases than females where the males 18 (60%) while females 12 (40%) [17]. According to pathological findings related to the mechanism of injury, this study found falling got the higher number of cases of patients in the mechanism injury where it got 13 (43.33%) while the heavy attack was the lowest where got 6 (20%). Based on the AIS grades, Falling have A — A Car accident, A — C, and Heavy attack A — D.

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Although, the French study mentioned that the FA value at the site of injury have the highest cases of patents [18,19]. However, our study found that the FA value above got more cases in comparison with the control group. This study had a comparison which found that the patients' group got high than a control group that FA value above have patients group 0.531 ± 0.105 while 0.534 ± 0.076 for the control while the FA value at the site of injury found 0.341 ± 0.132 for patients group and 0.534 ± 0.077 for the control group and FA value below had 0.436 ± 0.162 for patients group and 0.534 ± 0.076 for the control group. In the assessment of the quality of life of traumatic spinal cord injuries patients, the physical side had the biggest effect on the patients where the patients group had 64.88 ± 2.13 while the control group have 77.45 ± 1.36 with a p-value of 0.0435. The American studies have combined with our study that traumatic spinal cord injuries have big effected on the physical side and psychology side. [20,21]
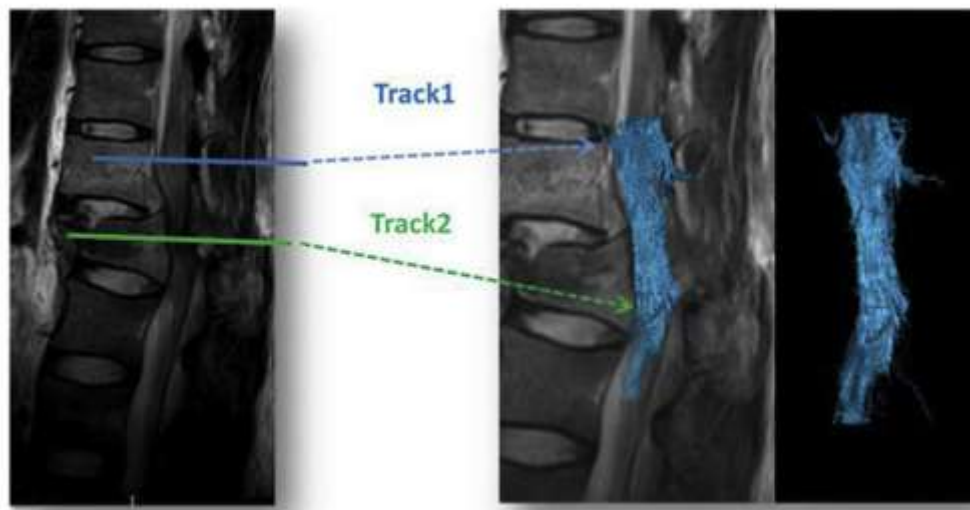

Figure B- Diffusion tensor tractography parameter detection method.

Conclusion

In conclusion, higher FA levels imply the integrity of the spinal nerves since they directly reflect the degree of myelination. By comparing our patients to controls, no discernible difference was found in the mean FA levels at or below the damage threshold. Also, the quality of life of patients found that all four parameters got higher evaluation in the control group in comparison to the patient group.

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