ROLE OF MRI DIFFUSION TENSOR IMAGING IN EARLY DIAGNOSIS OF CERVICAL SPONDYLOTIC MYELOPATHY (CSM).

Omar Farouk Kamel,[1] Ahmed Mahmoud Mohamed Ismail[2], Maha Abdel Meguid El-shinnawy,[1], Sherine Ibrahim Elwan[2] and Ahmed Elshimy,[1].

[1]Department of Diagnostic and Interventional Radiology, Faculty of Medicine, Ain Shams University, Cairo, Egypt.
[2]Department of Diagnostic Radiology, Mataryia Teaching Hospital, Egyptian ministry of Health and Population, Cairo, Egypt.

Corresponding author:
Ahmed Elshimy
Mobile: +2 01001294030
e.mail: **:**
ahmedchimi@hotmail.com

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ABSRACT

Background: *Cervical spondylotic myelopathy (CSM) represents a common cervical spine degenerative disease and is one of the most common causes of spinal cord functional impairment in older individuals worldwide. Assessing severity of the disease remains a challenge and there is still controversy regarding the most favorable timing for surgical intervention. Routine MRI is the gold standard radiological modality for spinal cord assessment; however, it cannot assess the underlying microstructural deficits of the cord and has a limited application in determining prognosis of the disease.*

Ain of the study*: to assess the utility of diffusion tensor imaging as an imaging technique in clinically suggested CSM patients by obtaining the microstructural parameters (FA and ADC) in the cervical spinal cord segments.*

Results: *Our study had 23 females (57.5%) and 17 males (42.5%). Their age ranged from 30 to 72 years with mean age of 47.3 ± 9.79 years.*

Our study showed considerable discrepancy in mean FA and ADC values between normal and stenotic segments of cervical spinal cord and revealed reasonable correspondence between European myelopathy score (EMS) and DTI parameters. FA and ADC values showed better results in detecting CSM in patients who were classified as grade 1 according to EMS compared to routine MRI T2WI. DTI is more sensitive in recognition of early myelopathy changes compared to conventional MRI

Conclusions*: DTI enhances the effectiveness of MRI in the evaluation of CSM at initial stages. Therefore, it helps to decide the optimal timing of surgical decompression prior to the chronic irreversible changes.*

Key words*: Cervical spondylotic myelopathy, Diffusion tensor imaging, Fractional anisotropy, Apparent diffusion coefficient.*

INTRODUCTION:

CSM is a degenerative disorder of the cervical spine. Progressive spinal cord injury results from age-related structural changes to the cervical spine components such as vertebral bodies, facet joints, ligaments and intervertebral discs[1].

Since it emerged, MRI has provided an indispensable role in diagnosis of CSM. There were enormous developments in MRI technology that led to improved resolution and quality of images over the past few decades. The use of MRI in diagnosis of CSM has progressed in parallel with improvement of image quality, developing gradually from a diagnostic tool to a non-invasive modality

that predicts neurological consequences and response to surgical management[2].

Despite being the imaging modality of choice for assessing cervical cord abnormalities, MRI offers limited information for definite disease diagnosis and outcome prediction. The apparent discrepancy between MRI findings and clinical manifestations results from the inherent heterogeneity of the clinical presentation in CSM and the inability of the conventional MRI to highlight microstructural spinal cord changes associated with CSM. Conventional MRI signs of spinal cord spondylotic myelopathy changes include high signal intensity in T2 weighted images and decrease in the anteroposterior diameter of the cervical cord representing cystic necrosis and atrophy; however, these signs appear obviously in late irreversible stages[3]. The radiological detection and analysis of CSM should be done early, as surgery decompression which is done during early course of the disease was revealed to be associated with better outcomes compared to surgical intervention which is performed at late stages[4].

The principle of DTI depends on the water molecules diffusion rate within CNS tissues; hence, it can indirectly reveal the pathological microstructure of the spinal cord. Therefore, disease process changing motion of water molecules within cervical spinal cord can be recognized at a microscopic level[1].

AIM OF THE STUDY:

to assess the utility of diffusion tensor imaging as an imaging technique in clinically suggested CSM patients by obtaining the microstructural parameters (FA and ADC) in the cervical spinal cord segments.

PATIENTS AND METHODS:

Our study was a prospective cross-sectional study including 40 patients (23 women and 17 men; age range 30–72 years) complaining of clinical manifestations of cervical compressive myelopathy including neck pain that radiates to upper limbs, tingling and inability to perform tasks such as handwriting. The patients were enrolled in the study from March of 2022 to December of 2022. They were sorted according to the clinical presentation based on European myelopathy score into three grades as follows: grade one, grade two and grade three. An informed and written consent has been obtained from the patients prior to MRI study. Patients with history of neurological disorders, stroke and cervical trauma were excluded.

The study was performed at radiology departments of faculty of medicine Ain Shams University and Matarya Teaching Hospital. No special preparation was needed.

MRI protocol:

The examinations were conducted by using a standard 1.5 Tesla MRI scanner (Ingenia, Philips). A standard cervical coil was used. Non enhanced T1 and T2 weighted images were obtained to provide a morphological assessment of cervical spinal cord and a reference image for comparing DTI and T2WI sensitivity in detecting the early stages of the disease. Then axial gradient-echo and Diffusion Tensor sequences were done.

DTI consisted of:

- A single shot, spin echoplanar sequence in 33 encoding directions.
- A diffusion weighting factor (b-value) of 0 & 1000 s/ mm2- TR 2800 ms-TE 97 ms- Flip angle 90˚- Matrix 80 x 108- FOV 248 mm- Slice- thickness: 2.0/00-
- Acquisition plane: Sagittal.

Sagittal T2WI:

- TR 3000 ms- TE 120 ms- Matrix 176x200- FOV 250- Flip angle 90°- Slice thickness: 3.5/1.

Sagittal T1WI:

- TR 400 ms- TE 7.8 ms- Matrix 176x200- FOV 250- Flip angle 90°- Slice thickness: 3.5/1.

Axial FFE WI:

- TR 492 ms- TE 9 ms- Matrix 132x129- FOV 150- Flip angle 25°- Slice thickness: 4.0/0.6.

Images were moved to workstation to be further processed and analyzed.

Image analysis:

For all patients, cervical spinal cord segments starting from C2/C3 down to C6/C7 levels were examined to assess presence of myelopathic changes on conventional T2 weighted images (Figure 1 A, B and C).

DTI parameters at spinal cord segments were generated and measured using DTI sequence post processing. Multiple ROIs were done within the cord in axial and sagittal integrated color-coded and anatomical images at each spinal cord level (figure 2, A and B). The performed ROIs involved cervical cord with exclusion of any surrounding CSF.

FA and ADC values at each spinal segment level, maximum compression level (at 3, 9 and 12 o'clock positions), conventional T2 weighted imaging characteristics and EMS scores were recorded. Evaluation of color-coded images was performed to recognize changes in normal blue color of the cranio-caudal oriented cervical cord fibers.

Statistical Analysis:

For each of examined patients, the patient's gender, age, DTI parameter, most stenotic levels, EMS and routine T2WI findings were obtained, and data was recorded in Microsoft Excel spreadsheet. The collected data was revised for accuracy and completeness then coded and analyzed using the statistical package for the social science version 21 (SPSS Inc., Chicago, Illinois, USA) on a personal computer.

Quantitative data were expressed as range, mean and ± standard deviation (SD) and qualitative data were expressed as frequency and percentage.

Comparison of DTI parameters; FA and ADC at normal and stenotic segments has been done by Monte Carlo Exact test and Fisher Exact test. P-value level of significance (Highly significant (HS) = $P<0.01$, Significant (S) = $P<0.05$ and Non-significant (NS) = $P>0.05$. ROC (receiver operating characteristic) analysis was performed to detect cutoff values for DTI parameters at different spinal cord levels (excellent = 0.9-1, good = 0.8-0.9, fair = 0.6-0.7, poor = 0.6-0.7 and failed result = 0.5-0.6).

Ethics Approval and Consent to Participate:

This study was approved by the Research Ethics Committee of the Faculty of Medicine, Ain Shams University in Egypt on 1/03/2020; Reference Number of approval: FWA000017585 (No: FMASU M S 369/2020).

A written informed consent from all participants in the study was obtained after a thorough explanation of the study protocol to them.

RESULTS:

The study results are illustrated in the following tables and figures.

As shown in table (1) we have examined 40 outpatients. Age of these patients ranged from 30 to 72 years old with a mean age of 47.3 ± 9.79 (mean ± SD). The examined patients included 23 females (57.5%) and 17 males (42.5%).

Table (1): Illustration of the demographic features of the study.

	Frequency	Percentage (%)
Age		
Min. – Max.	30.0 – 72.0	
Mean ± SD	47.3 ± 9.79	
Sex		
Male	17	42.5
Female	23	57.5
Total	40	100.0

As shown in table (2) the patients were sorted as regarding the clinical presentation on basis of European myelopathy score into three categories as follows: 20 patients (50%) as grade 1, 13 patients (32.5%) as grade 2 and 7 patients (17.5%) as grade 3.

Table (3) shows that out of 40 patients, 23 patients (57.5%) showed normal mean ADC value at the cervical spinal cord segments and 17 patients (42.5%) showed increased mean ADC value at the cervical spinal cord segments. Out of the 17 patients, 3 patients have been sorted as grade 1, 7 patients have been sorted as grade 2 and 7 patients have been sorted as grade 3 according to EMS. Out of 40 patients, 24 patients (60%) had normal mean FA value and 16 patients (40%) had decreased mean FA value. Out of the 16 patients, 5 patients were classified as grade 1, 5 patients were classified as grade 2 and 6 patients were classified as grade 3 according to EMS.

Table (2): Distribution of the studied patients according to the European myelopathy score.

EMS	Frequency	Percentage (%)
Grade 1	20	50.0
Grade 2	13	32.5
Grade 3	7	17.5
Total	40	100.0

Table (3): Mean DTI parameter at the cervical spinal cord segments in studied patients.

Total ADC values	Frequency	Percentage (%)	**Total FA values**	Frequency	Percentage (%)
Normal values	23	57.5	Normal values	24	60.0
Increased values	17	42.5	Decreased values	16	40.0
Total	40	100.0	Total	40	100.0

Table (4) shows that T2 weighted imaging implied great value in detecting myelopathy changes in grade 3 patients (71.4%) but showed poor results in detecting myelopathy changes in grade 1 patients (0%). On the other hand, DTI parameters showed better results in detecting myelopathy changes in grade 1 patients. Out of the 20 patients who were classified as grade 1 according to EMS, 5 patients (25%) showed decreased mean FA values and 3 patients (15%) showed increased mean ADC values; however, no alteration in the signal intensity of T2 weighted images was detected in those 20 patients (0%). Out of the 13 patients who were classified as grade 2 according to EMS, 5 cases (38.5%) showed decreased mean FA values and 7 cases (53. 8%) showed increased mean ADC values while only one case (7.7%) had T2WI signal changes. Out of the 7

patients who were classified as grade 3 according to EMS, 6 cases (85.7%) showed decreased mean FA values, 7 cases (100%) showed increased mean ADC values and 5 cases (71.4%) T2WIs signal intensity changes.

Table (4): Number of patients with mean FA values, men ADC values and T2WI representing negative and positive test compared to EMS.

	EMS score											
	Grade 1 (20 cases)			Grade 2 (13 cases)			Grade 3 (7cases)			Total (40)		
	FA	ADC	T2WI	FA	ADC	T2WI	FA	ADC	T2WI	FA	ADC	T2WI
-ve	15 75%	17 85%	20 100%	8 61.5%	6 46%	12 92.3%	1 14.2%	0 0%	2 28.6%	24 60%	23 57.5%	34 85%
+ve	5 25%	3 15%	0 0%	5 38.5%	7 54%	1 7.7%	6 85.8%	7 100%	5 71.4%	16 40%	17 42.5%	6 15%

P-value = 0.019 (Statistically significant) for FA compared to EMS, P-value = <0.001 (highly significant) for ADC compared to EMS and P-value = <0.001 (Highly significant) for T2WI signal intensity changes compared to EMS.

Table (5) illustrates comparison between average FA and ADC at both stenotic and non-stenotic segments of the cervical spinal cord. The average FA value at stenotic segments measured 0.45 compared to 0.65 at non-stenotic segments and the average ADC value at stenotic segments measured 1.49 compared to 1.21 in non-stenotic segments.

Table (6) shows that FA sensitivity and specificity in prediction of myelopathic changes were 73.5% and 83.3% respectively and ADC sensitivity and specificity in prediction of myelopathic changes were 100% and 70.6% respectively (Figure 3 A and B).

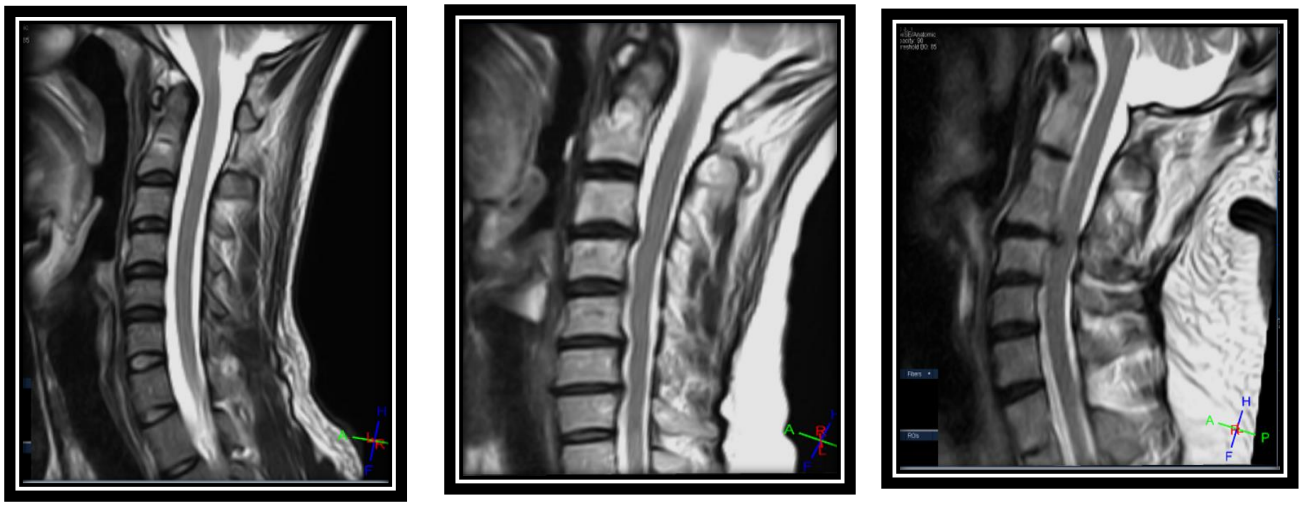
Table (7) shows FA and ADC cut off values at cervical spinal cord segments.

Table (5): FA and ADC values at stenotic and non-stenotic segments of cervical spinal cord.

	No. of cases	FA Values (Mean ± SD)	ADC Values (Mean ± SD)
C2-3			
Normal (No stenosis)	40	0.62 ± 0.10	1.1 ± 0.27
C3-4			
Normal (No stenosis)	33	0.62 ± 0.05	1.05 ± 0.16
Stenosis	7	0.45 ± 0.15	1.35 ± 0.29
C4-5			
Normal (No stenosis)	34	0.56 ± 0.08	1.22 ± 0.22
Stenosis	6	0.42 ± 0.15	1.92 ± 1.12
C5-6			
Normal (No stenosis)	29	0.53 ± 0.09	1.31 ± 0.49
Stenosis	11	0.47 ± 0.04	1.41 ± 0.26
C6-7			
Normal (No stenosis)	32	0.53 ± 0.10	1.38 ± 0.54
Stenosis	8	0.47 ± 0.07	1.30 ± 0.26

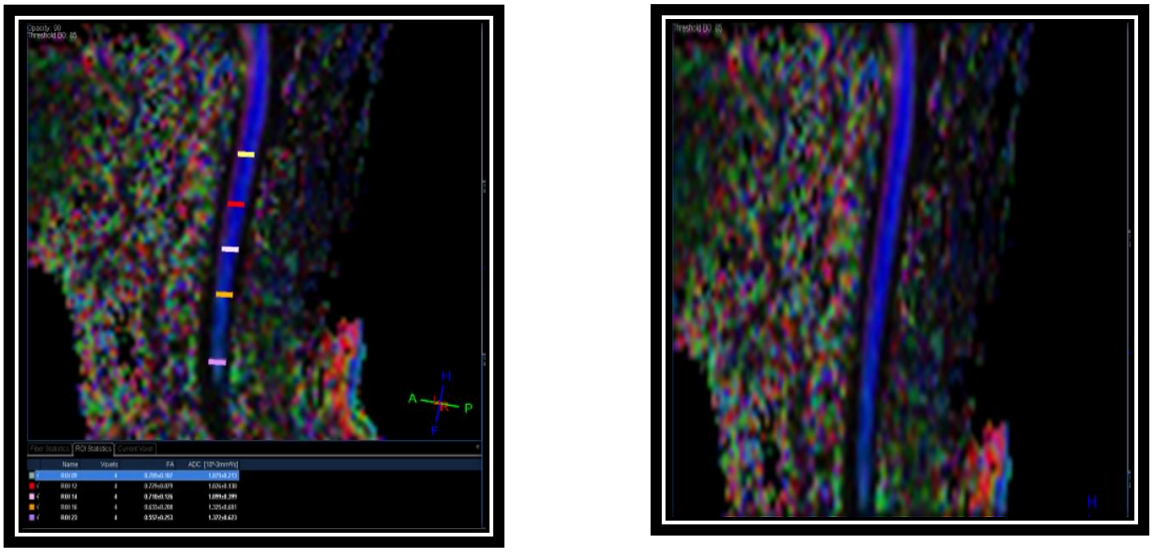
Table (6): DTI parameters sensitivity, specificity, positive predictive value and negative predictive value in prediction of myelopathic changes.

Cutoff	AUC	Standard error	P value	Lower Bound 95% CI	Upper Bound 95% CI	Sensitivity	Specificity	PPV	NPV	Accuracy
2.755	0.77	0.101	0.037	0.571	0.969	73.5%	83.3%	96.2%	35.7%	75.0%
6.01	0.831	0.067	0.011	0.699	0.963	100.0%	70.6%	37.5%	100.0%	75.0%



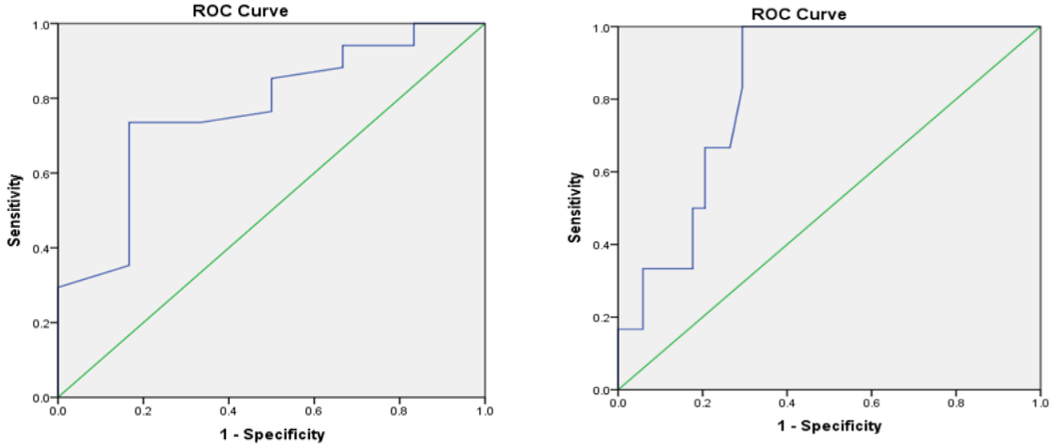
A **B** **C**

Figure 1: Sagittal T2 MRI weighted images. (A) A 30-year-old male complained of cervical pain and was classified as grade 1 according to the European myelopathy score with normal sagittal T2WI revealing no obvious alteration in signal intensity in the spinal cord. (B) A 57-year-old female who was classified as grade 2 according to EMS with sagittal T2WI revealing C3-4 down to C6-7 posterior bulges of inter-vertebral discs. (C) A sagittal T2WI revealing significant spondylotic spinal changes at C4-5 level with severe canal stenosis and indentation of the thecal sac in a 52-year-old male who was classified as grade (3) according to EMS.



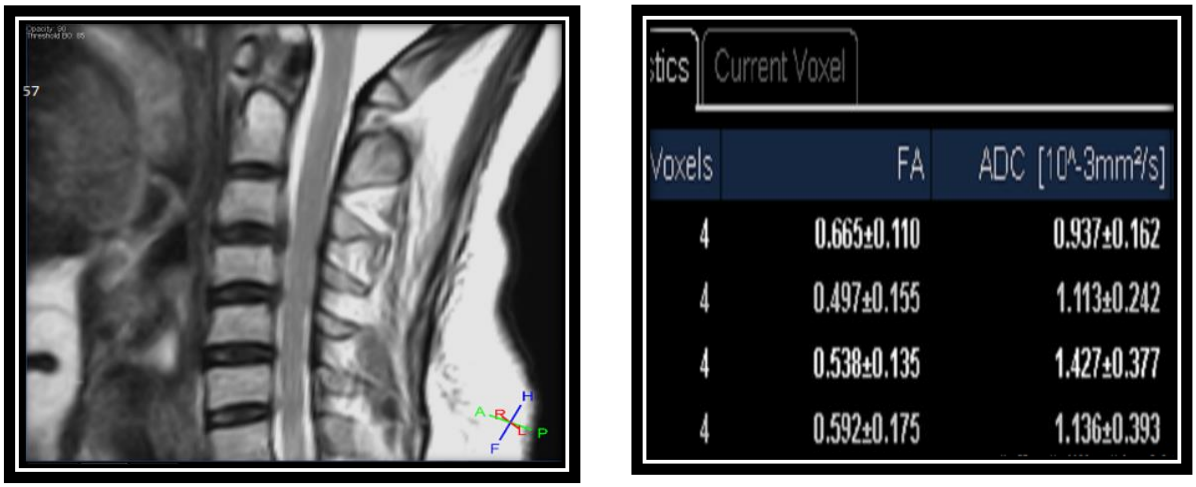
A **B**

Figure 2: Sagittal color-coded images. (A) FA and ADC Measurement at each spinal segment. (B) Normal sagittal color-coded map.



A **B**

Figure 3: (A) illustrating the sensitivity and specificity of FA in recognition of myelopathic changes. (B) illustrating the sensitivity and specificity of ADC in recognition of myelopathic changes.



A **B**

Figure 4: A 55-year-old female patient who was classified as grade 2 according to EMS.
(A) Sagittal T2 weighted image revealing C3-4 and C4-5 levels posterior disc bulges.
(B) DTI parameters at spinal cord segments showing significant decrease of FA value at C3-4 and C4-5 levels (0.49 and 0.53) with corresponding increase in ADC value at same level (1.11 and 1.42)

Table (7): FA and ADC cut off values at cervical spinal cord segments.

Level	FA mean ±SD	ADC mean ±SD
C2-3	0.6 ± 0.10	1.1 ± 0.27
C3-4	0.6 ± 0.09	1.1 ± 0.22
C4-5	0.5 ± 0.10	1.3 ± 0.52
C5-6	0.5 ± 0.09	1.3 ± 0.44
C6-7	0.5± 0.10	1.4 ± 0.50

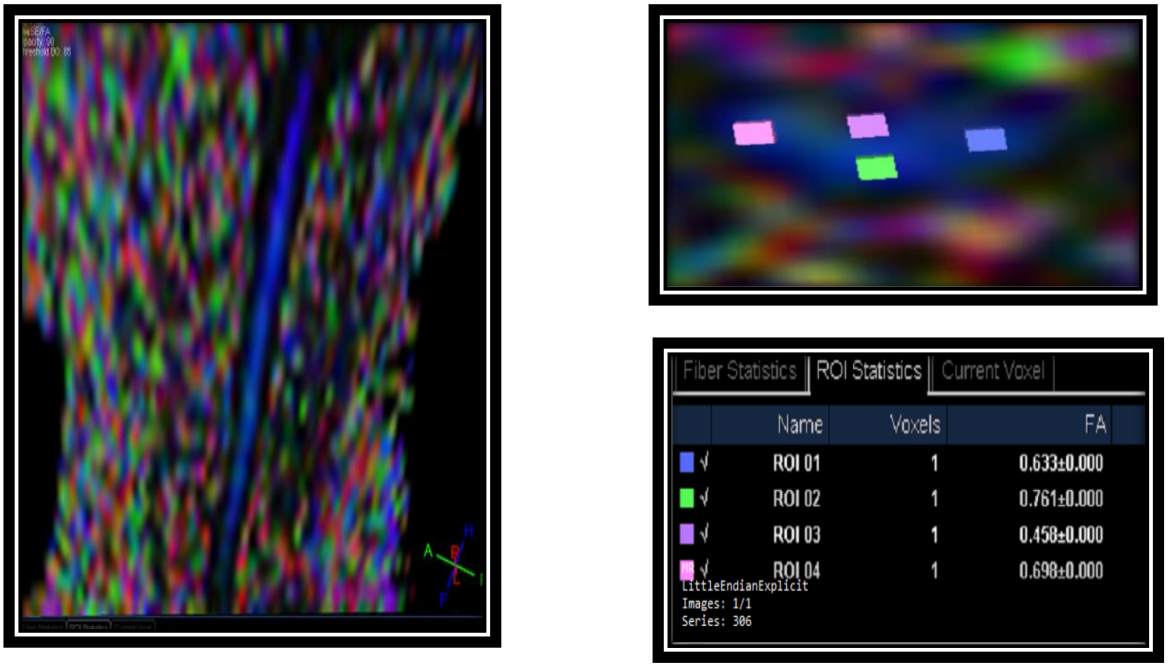
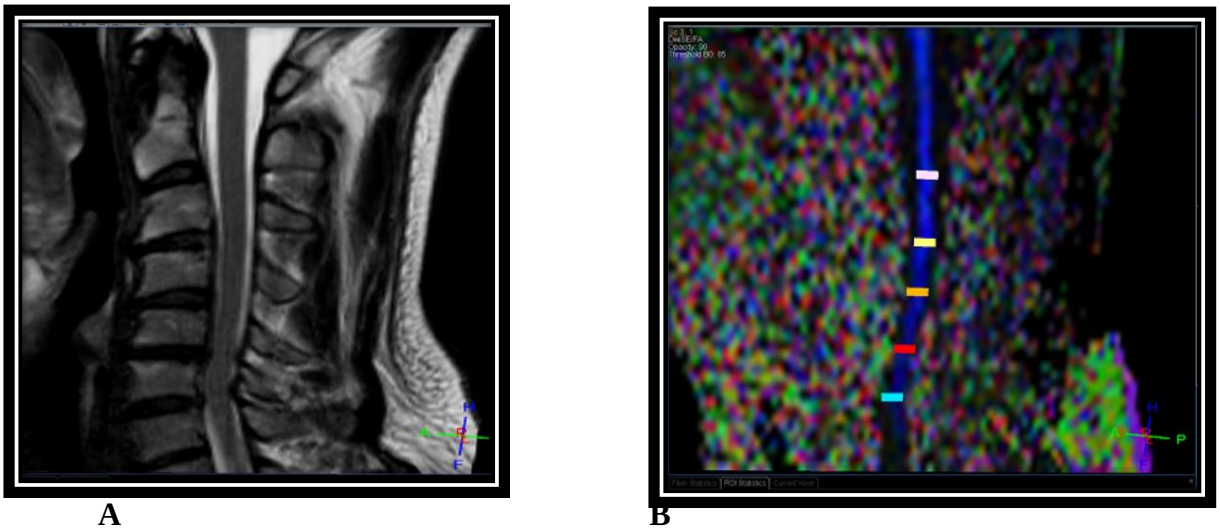


Figure 5: Sagittal color-coded image showing altered blue color of the cord opposite to C5-6 in a 57-year-old female patient who was classified as grade 2 according to EMS.



A **B**

C

Figure 6: A 55-year-old male presented with clinical picture corresponding to grade 3 EMS. (A) Sagittal T2WI showing significant spondylotic spinal changes with canal stenosis and indentation of the thecal sac at C5-6 and C6-7 levels. (B) Sagittal color-coded image with FA and ADC values measurement at spinal cord segments. (C) DTI indices revealing significant reduction of FA value opposite C5-6 and C6-7 levels (0.49 and 0.34) and increase in ADC value at same levels (1.31 and 1.54).

DISCUSSION

CSM represents a common cause of functional impairment of spinal cord [5], affecting greater than 60% of the people beyond 40 years of age[6]. Generally, it progresses chronologically over years because of spinal cord compression resulting from thickening and calcification of the posterior longitudinal ligaments[7].

Plain radiography & CT may be useful in the initial evaluation of cervical spondylotic changes; however, MRI remains the imaging modality of choice for CSM particularly on T2 weighted images to evaluate any signal intensity changes at the spinal cord[8].

Regrettably, assessment of CSM by routine reveals weak correspondence with patient's clinical symptoms, as proposed by the results of clinical studies illustrating a diagnostic sensitivity between 15 % and 65 % in patients with severe signs and symptoms of CSM [9]. Contrarily, proper evaluation of CSM has clinical significance, as early treatment induction leads to greater outcomes[10].

The aim of our study was the evaluation of diagnostic reliability of DTI techniques in recognition of CSM disorder by obtaining the microstructural parameters in cervical spinal cord.

In this study, microstructural parameters (FA and ADC) of cervical spinal cord in CSM patients were compared with the clinical presentation of the patients based on the European myelopathy score and information obtained from conventional sequences (Figure 4 A, B and Figure 5).

Our concept was to compare DTI parameters with patients' cervical cord levels in normal and affected discs.

In our study, the mean age of the included patients was 47.3 ± 9.79. Nouri et al. [6], reported that among people above 40 years old, approximately 60% suffered from CSM. In William study [11], the distribution of age groups revealed that after the age of 50, the percentage of diseased discs exceeded that of normal discs and as the number of older persons increased, the incidence of CSM increased as well.

Our study showed that the severity of CSM increased with increasing age, which is in-agreement with Zhang et al. [12], who reported that age was inversely correlated with recovery and compared to young patients, elderly was more likely to have more severe and chronic course of the disease with multiple levels affection.

In our study, the included patients were sorted according to European myelopathy score into three categories and a great correspondence between EMS and DTI parameters was revealed (Figure 6 A, B and C). This is in-agreement with Dvorak et al. [13], who reported a significant correlation between FA and European myelopathy score being a valuable tool for the evaluation of all conditions involving cervical myelopathy.

In Facon study [14], normal FA values were measured in healthy volunteers at three different levels (cervical, C2–C5; high thoracic, T1–T6; and low thoracic, T7–T12) by using regions of interest located on the spinal cord avoiding CSF partial volume effect.

In our study we obtained FA values at spinal cord segments from C2 to C7 not opposite specific disc levels, and we avoided CSF partial volume effect as well.

In our study the most commonly affected cervical spinal cord segment was opposite C5-6-disc level, seen in 15 cases (37.5%) of the included patients. Our results are consistent with Qiao et al. [15], who concluded that the incidence of modic changes of the spinal cord was highest in the C5–6 segment and Zhang et al. [12], who concluded that, the most frequently affected level regardless of severity was C5/6 level.

The reason for these similar results may be the fact that axonal damage and demyelination caused CSM disorder are more affecting distal sites of spinal cord in the chronic stage of the disease [16].

In concordance with Nukala et al. [1] and Guan et al. [16], we reported that DTI parameters (FA and ADC) had higher sensitivity for detection of myelopathic changes than the conventional MRI in the early stage. In our study, out of the 20 patients who were classified as grade 1 according to EMS, 8 cases (40%) showed positive myelopathic changes by DTI parameters while no alteration in routine T2WI signal intensity was shown in those 20 patients (0%).

Our study showed a significant correlation between the number of cases who had myelopathic changes by DTI parameters and the severity of disease, which is in-agreement with Miraldi et al. [17], who reported that the more decreased FA value, the more neurological symptoms patients had and the worse outcome.

In concordance with Guan et al. [16], we reported that CSM patients showed great FA values decrease and ADC values increase opposite the most stenotic segment of cervical spinal cord. Our study revealed that mean FA values measured 0.45 in stenotic segments compared to 0.65 in non-stenotic segments and mean ADC values measured 1.49 in stenotic segments compared to 1.21 in non-stenotic segments. Guan et al. [16], showed that mean FA values measured 0.45 in stenotic segments compared to 0.57 in non-stenotic segments and mean ADC values measured 2.1 in stenotic segments compared to 1.3 in non-stenotic segments. Lwasaki et al. [18], reported that mean FA values measured 0.56 in stenotic segments compared to 0.8 in non-stenotic segments and He et al. [19], concluded that mean FA values measured 0.49 in stenotic segments compared to 0.61 in non-stenotic segments. In concordance with Kara et al.[4], mean FA values of the spinal cord opposite normal disc levels in our study measured 0.65, compared to 0.66 by Suetomi et al. [20], and to 0.72 by Nukala et al. [1].

ROC curves were obtained to determine FA and ADC cut off values at cervical spine segments. FA and ADC cut off values at level of C2-3 were 0.6 (± 0.10) and 1.1 (± 0.27) respectively, at level of C3-4 were 0.6 (± 0.09) and 1.1 (± 0.22) respectively, at level of C4-5 were 0.5 (± 0.10) and 1.3 (± 0.52)respectively , at level of C5-6 were 0.5 (± 0.09) and 1.3 (± 0.44) respectively and at level of C6-7 were 0.5 (± 0.10) and 1.4 (± 0.50) respectively. In Nukala et al. study [1], FA and ADC cut off values at level of C2-3 were 0.65 and 1.03 respectively, at level of C3-4 were 0.63 and 1.01 respectively, at level of C4-5 were 0.57 and 1.04 respectively, at level of C5-6 were 0.57 and 1.04 respectively and at level of C6-7 were 0.56 and 0.96 respectively. In Huismann study [21], ADC cut off value at level of C2-3 was 1.25, at level of C3-4 was 1.32, at level of C4-5 was 1.29, at level of C5-6 was 1.29 and at level of C6-7 was 1.42.

Nukala et al. [1], reported that FA sensitivity and specificity in recognition of myelopathy changes were 78.8% and 79.7 % respectively and ADC sensitivity and specificity were 71.4% and 62.1% respectively. In our study, FA sensitivity and specificity were 73.5% and 83.3% respectively while ADC sensitivity and specificity were 100% and 70.6% respectively. In Demir et al. [22] study, ADC sensitivity and specificity were 80% and 53% respectively.

Conclusions:

Diffusion tensor imaging parameters (FA and ADC values) along with conventional MRI images, comprehensive history and clinical examination are promising tools in:

(1) Providing information about the spinal cord microstructure and integrity.

(2) Identifying changes of cervical spondylotic myelopathy disorder at early

stage before being evident on conventional T2WI.

(3) Assessing the severity and the extent of cervical spine myelopathic changes.

(4) Accentuating the decompression surgery clinical success, which would be greater when conducted at the early course of the disease.

(5) Using FA and ADC values as objective measures for following the patients up, avoiding subjective characteristic of T2 weighted images.

Competing interests:

We have no competing interests to declare.

LIMITATIONS

We could not be able to track and follow up the myelopathic changes of the patients. Furthermore, there was no pathological correlation with radiological imaging.

Consent for publication:

A written informed consent for participation was obtained by each patient.

Availability of data and materials:

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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This study had no funding from any resource.

Authors Contribution:

All authors read and approved the final manuscript.

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List of abbreviations

- Cervical spondylotic myelopathy = CSM
- Diffusion tensor imaging = DTI
- Fractional anisotropy = FA
- Apparent diffusion coefficient = ADC
- European myelopathy score = EMS.

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دورالتصوير بالرنين المغناطيسي بالانتشار الموتر فى التشخيص المبكر لحالات الاعتلال العصبى النخاعى للفقرات العنقية.

عمر فاروق كامل[1] واحمد محمود محمد اسماعيل [2] ومها عبد المجيد الشناوي[1] و شيرين ابراهيم علوان[2] واحمد الشيمى[1]

1-قسم الاشعة التشخيصية كلية طب جامعة عين شمس القاهر مصر

2- مستشفي المطريه التعليمي بوزاره الصحه قسم الاشعة التشخيصية

الخلفية: يمثل اعتلال النخاع الفقاري العنقي مرضًا شائعًا في العمود الفقري العنقي وهو أحد الأسباب الأكثر شيوعًا لضعف وظيفي في النخاع الشوكي لدى الأفراد الأكبر سنًا في جميع أنحاء العالم. لا يزال تقييم شدة المرض يمثل تحديًا ولا يزال هناك جدل بشأن أفضل توقيت للتدخل الجراحي. التصوير بالرنين المغناطيسي الروتيني هو الطريقة الإشعاعية القياسية الذهبية لتقييم الحبل الشوكي. ومع ذلك ، لا يمكن تقييم أوجه القصور الهيكلية المجهرية الكامنة في الحبل ولها تطبيق محدود في تحديد تشخيص المرض.

الهدف من الدراسه: تقييم فائدة التصوير الموتر للانتشار كأسلوب تصوير في مرضى اعتلال النخاع الفقاري العنقي المقترحين سريريًا من خلال الحصول على المعلمات الهيكلية المجهري في مقاطع الحبل الشوكي العنقي.

النتائج: ضمت دراستنا 23 إناث (57.5٪) و 17 ذكور (42.5٪). تراوحت أعمارهم من 30 إلى 72 سنة بمتوسط عمر 47.3 ± 9.79 سنة.

أظهرت دراستنا تباينًا كبيرًا في متوسط قيم FA و ADC بين الأجزاء الطبيعية والتضيقة من الحبل الشوكي العنقي وكشفت عن تطابق معقول بين درجة اعتلال النخاع الأوروبي ومعلمات DTI. أظهرت قيم FA و ADC نتائج أفضل في اكتشاف اعتلال النخاع الفقاري العنقي في المرضى الذين تم تصنيفهم على أنهم من الدرجة الأولى مقارنةً بالتصوير بالرنين المغناطيسي الروتيني. يعتبر DTI أكثر حساسية في التعرف على التغيرات المبكرة في اعتلال النخاع مقارنةً بالتصوير بالرنين المغناطيسي التقليدي.استنتاجات: DTI يعزز فعالية التصوير بالرنين المغناطيسي في تقييم اعتلال النخاع الفقاري العنقي في المراحل الأولية. لذلك ، فإنه يساعد على تحديد التوقيت الأمثل لإزالة الضغط الجراحي قبل التغييرات المزمنة التي لا رجعة فيها.