ABSTRACT

Introduction: Multiple investigation modalities have been invented for diagnosis and for planning management of degenerative cervical myelopathy, which include magnetic resonance imaging (MRI), computed tomography scan, and plain X-rays. Diffusion tensor imaging (DTI) of the spinal cord is a special variety of MRI where diffusion of water molecules across and along the tracts is mapped. The changes in anisotropy at the stenotic level can be a postoperative prognostic factor. The aim of this study was to establish postoperative prognostic predictive value of DTI in cases of degenerative cervical myelopathy.

Materials and Methods: The study included 30 indoor patients in a tertiary care hospital diagnosed with degenerative compressive cervical myelopathy based on both clinical and radiological parameters with complete clinical data including follow-up. All patients with medical neurological diseases, cases who underwent repeat surgery, cases who developed surgical site infection, and those patients who were lost to follow-up were excluded from the study. The patients underwent operative decompression through either anterior or posterior approach with or without fixation with titanium implants as per indication. All patients underwent pre- and postoperative DTI. The fractional anisotropy (FA) and apparent diffusion coefficient (ADC) were noted in both pre- and postoperative imaging. Epidemiological data such as age and sex were noted. Pre- and postoperative modified Japanese Orthopedic Association (mJOA) scores were calculated.

Results: There was a significant improvement in FA values postoperatively. Preoperatively, both FA and ADC values showed a significant correlation with preoperative Neurological status of the patient while postoperatively only FA values were found to be significantly correlated. The regression equations for determining postoperative mJOA score based on preoperative FA and ADC values revealed mJOA = 9.77 + 12.1 (FA), mJOA = 14.2 + 2408.4 (ADC), and mJOA = 9.54 + 11.2 (FA) +1575.5 (ADC). This means that postoperative mJOA score, i.e., postoperative clinical status improvement can be determined using DTI variables which are an objective preoperative data. However, relative strength of prediction for FA value is 66.7% and for ADC value is 28.7%.

Conclusion: DTI tractography of the spinal cord will be a helpful objective prognostic factor for patients in whom surgery is planned. However, a study with larger subject size is required to increase the accuracy of determination of regression coefficient.

Keywords: Diffusion tensor imaging, myelopathy, prognostic

INTRODUCTION

Multiple investigation modalities have been invented for diagnosis and for planning management of degenerative cervical myelopathy, which include magnetic resonance imaging (MRI), computed tomography scan, and plain X-rays. Diffusion tensor imaging (DTI) of the spinal cord is a special variety of MRI where diffusion of water molecules across and along the tracts is mapped. The changes in
anisotropy at the stenotic level can be a postoperative prognostic factor.

The aim of this study was to establish postoperative prognostic predictive value of DTI in cases of degenerative cervical myelopathy.

MATERIALS AND METHODS

The study included 30 indoor patients (29 males and 1 female) who visited a tertiary care hospital during a period from September 2013 to September 2015 diagnosed with degenerative compressive cervical myelopathy based on both clinical and radiological parameters with complete clinical data including follow-up. All patients with medical neurological diseases, cases who underwent repeat surgery, cases who developed surgical site infection, and those patients who were lost to follow-up were excluded from the study. The patients underwent operative decompression through either anterior or posterior approach with or without fixation with titanium implants as per indication.

After approval from the Institutional Ethics Committee, all patients underwent pre- and postoperative DTI of the cervical spine with 1.5-Tesla magnetic power imaging machine [Figures 1 and 2]. Postoperative imaging was done 6 weeks postoperatively after complete wound healing and subsidence of soft-tissue edema.

The fractional anisotropy (FA) and apparent diffusion coefficient (ADC) were noted in both pre- and postoperative imaging. Epidemiological data such as age and sex were noted. Pre- and postoperative modified Japanese Orthopedic Association (mJOA) scores were calculated [Figure 3].

RESULTS

There was a significant improvement in FA values postoperatively. Preoperatively, both FA and ADC values showed a significant correlation with preoperative neurostatus of the patient. This means that, on preoperative imaging, the reduction in FA and increase in transverse ADC at the stenotic level could be positively correlated with severity judged by mJOA score [Tables 1 and 2], while postoperatively only improvement in FA values could be correlated significantly with improved mJOA score. The regression equations for determining postoperative mJOA score based on preoperative FA and ADC values revealed:

- \( m\text{JOA} = 9.77 + 12.1 \times (\text{FA}) \)
- \( m\text{JOA} = 14.2 + 2408.4 \times (\text{ADC}) \)
- \( m\text{JOA} = 9.54 + 11.2 \times (\text{FA}) + 1575.5 \times (\text{ADC}) \).

This means that postoperative mJOA score, i.e., postoperative clinical status improvement can be determined using DTI variables which are an objective preoperative data. However, relative strength of prediction for FA value is 66.7% and for ADC value is 28.7%. This means that, in only 66.7% of cases, postoperative mJOA score could be accurately predicted based on preoperative FA values. It was also found that in severe cases (mJOA <9), the predicted postoperative improved score exceeds actual score, but statistical significance of this finding could not be established because of smaller subject size.

DISCUSSION

The degenerative compressive cervical myelopathy is one of the common disabling conditions affecting the cervical spine in adults. The pathologies include degenerative disc disease, ossified posterior longitudinal ligament, and
The basic motivation for this study was a common clinical to imaging mismatch arising out of variable individual tolerance of the spinal cord to the compression caused by degenerative spinal canal narrowing. It has been demonstrated by animal model experiments that spinal cord function may be surprisingly resistant to compression. This also manifests in the relatively common accidental findings of asymptomatic spondylotic cervical spinal cord compression. Thorpe et al. described degenerative changes of the cervical spine in 64% of a target group of asymptomatic individuals at ages between 18 and 72 years, and spinal cord compression was noted in 11% of the group.

Although it was initially done for spinal cord injuries, tumors, and neurological diseases such as multiple sclerosis, degenerative compressive myelopathy also demonstrated...
significant changes in FA and ADC values of the affected stenotic segment in both animal models and human beings.[12]

The advantage of this imaging is that it gives objective data, which removes interobserver variability in interpretation of the conventional MRI. In various studies, it was established that there is a significant decrease in FA and ADC values at the stenotic level of the cervical spine. In our study, we found that there was an improvement in these values after operative decompression. The pre- and postoperative clinical status of these patients was assessed using mJOA. The correlation between preoperative values of FA and ADC with postoperative mJOA score was established using statistical analysis.

This study revealed that there was a significant correlation between preoperative FA and ADC values measured at the level of maximum compression (as seen on conventional imaging) with preoperative mJOA score, that is, preoperative clinical status of the patient can be predicted using these values. The regression equations for preoperative FA and ADC values and postoperative mJOA score were established during statistical analysis of this study. These equations can be used to predict postoperative mJOA score for a particular patient using preoperative FA values. However, as stated earlier, the relative strength of prediction of accurate value using FA was only 66.7% and that for ADC was 28.7%, which means that a study with larger subject size is required to increase accuracy of prediction and to establish more accurate equation. It should also be noted that the relative reduction in the anisotropy would be more relevant than the absolute values of FA and ADC in predicting the outcome. The accuracy can also be improved using 3-Tesla MRI technique.

CONCLUSION

DTI of the spinal cord will be a helpful objective prognostic factor for patients in whom surgery is planned. However, a study with larger subject size is required to increase the accuracy of determination of regression coefficient. The cost–benefit ratio still remains a question in Indian scenario.

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Conflicts of interest
There are no conflicts of interest.

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