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Correlation between Clinical Pain in Temporomandibular Disorders and Signal Intensity of the Retrodiscal Tissue Using Fluid Attenuation Inversion Recovery MRI – A Cross Sectional Study

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ABSTRACT

Temporomandibular disorders (TMD) is a broad term referring to pain and dysfunction of temporomandibular joint (TMJ), nmasticatory muscles and its associated structures. TMD is the most common orofacial pain condition with prominent feature like regional pain in the face and preauricular area during static and dynamic movements. Methods of assessing clinical pain were subjective and not affirmative. There still remains element of drafting the clinical pain evaluation in TMD patients. This study correlated the pain range in TMD patients with the levels of signal intensity (SI) in FLAIR MRI (Fluid Attenuation Inversion Recovery magnetic resonance imaging) to devise an objective pain assessing system based on the SI values. Settings and design: The present study is institution based, observational cross sectional study. A 32 temporomandibular joints were evaluated in the study. Before imaging, subjective pain score were recorded using Visual Analog Scale (VAS). In FLAIR MRI, both grey matter and retro discal tissue were included in the Region of Interest and the SIRs were calculated. SIRs in painful temporomandibular joints were correlated with Visual Analog Scale score. Unpaired t test was used to compare the mean values recorded for SIR. P-value <0.05 is considered to be statistically significant. Study results shows that SIRs of retrodiscal tissue were significantly increased in patient with higher VAS score (p<0.05). Retrodiscal tissue in painful proteinous elements.

Keywords: Temporomandibular disorders; Signal intensity; FLAIR MRI; Retrodiscal tissue

1 INTRODUCTION

Temporomandibular joint, also known as ginglymodiarthroidal joint, is a complex system which is composedof two joints with articulating ligaments as well as masticatory muscles. It is located between the condylar process of the mandible and temporal bone of the cranium.[1] The intra-articular joint space is separated by a biconcave articular disc into an upper discotemporal and a lower discomandibular compartments.[2] TMJ movements are produced by the muscles of mastication and the hyoid bone. Any defect in this complex synovial system known as temporomandibular disorders.[1]

Temporomandibular disorders (TMD) represents a conglomerate of medical and dental conditions affecting the temporomandibular joints (TMJ) and the adjoining muscles and tissue components.[3,4] Literature evidences reveal that TMD is more prevalent between the age of 20 to 40 and shows a higher predilection for women.[5] It is a multifactorial disorder inclusive of biological, environmental, psychological factors and also associated with chronic illness and systemic conditions like arthritis, fibromyalgia and certain autoimmune conditions.[6,7] Clinically, it manifests with discomfort while opening and closing the mouth, may or may not be associated with joint noise and pain. The intensity of the pain could be mild, moderate or severe depending upon the etiological factors.[8]

The posterior part of the articular disc, known as retrodical tissue or meniscus[9] which is considered highly vascular[10–15] and well innervated.[16] Histological evidences prove that retrodiscal tissue exhibits increased vascularity in patients with TMD.[17] So, it plays a major role in the development of pain related TMJ disorders.[18–20] Fewer studies have compared the diagnostic efficacy of T2 weighed images and FLAIR images and affirmed that FLAIR sequence shows a better diagnostic accuracy compared to T2 weighed images. The supremacy of FLAIR is that it works by both fat and fluid attenuation

The diagnosis of the TMD become complex when the patient reports with the complaint of pain without any systemic illness where they do not manifest osseous pathologies as well.[21] MRI plays a pivotal role in assessing the intra articular components of the TMJ, especially the retrodical tissue.[9,22] The diagnostic accuracy was about 73-98% in symptomatic patients, with false positive results of 20-34% in asymptomatic patients.[23] The changes in soft tissue components of TMJ are well appreciated in T2 weighed images. T2 signal from this tissue is higher in painful joints when compared to the normal ones.[16]

The microscopic biochemical changes due to TMD will also lead to pain, and they are usually unnoticed in proton density and T2 weighed images.[24] Biochemical changes like higher protein content showed as increased SI in FLAIR sequences. The supremacy of FLAIR over T2 weighed images is that it works by both fat and fluid attenuation.Fluid attenuated inversion recovery (FLAIR) MR sequence has been used widely to diagnose brain lesions and also found useful in differentiating abscess from non-abscess lesions.[24] In the meantime, some studies have used this sequence to assess the abnormalities of TMJ by evaluating various sites and it has suggested that the signal intensities increased in the painful joints compared to non-painful joints. [25-[27] To reduce the rate of false positive results and to improve the accuracy of diagnosis, FLAIR sequence is incorporated in the study.

As the retrodiscal tissue area is considered as the primary site for pain development,[24] in this study we aimed to evaluate the correlation between the clinical pain range and the amount of increase in the signal intensities in FLAIR MRI in TMD patients. This could also be a reliable tool in assessing intensity of pain in retrodiscal tissue which may help in planning the treatment modality in the future.

2 MATERIALS AND METHODS

The study participants were selected from the outpatient department who reported with the chief complaint of pain in the temporomandibular joint region. Patients diagnosed with painful temporomandibular joint disorders based on Research Diagnostic Criteria [Table 6] between the age group of 20 to 50 years were included. The male to female ratio was 5:3. Patients with the history of masticatory muscle disorders, developmental disorders, and claustrophobic individuals, with cardiac pacemakers, implants, history of recent surgery, systemic inflammatory diseases, metallic restorations, pregnant women and patients who are unwilling to participate in the study were excluded from the study. The sample size was calculated using G*power, based on the sample size of the the parent article .keeping alpha error as 0.05and the power (1-β err problem)-0.95, the final sample size was obtained as 32. Patients were selected based on the Research diagnostic criteria. The research study was conducted based on the ethical principles of Helsinki declaration. All the eligible study participants were then selected and well-informed about the study and written consent was obtained. The method of the study was accepted by the Institutional Review Board (SRMDC/IRB/2017/MDS/No.901).

Prior to FLAIR MRI, the patients were asked to rate their degree of pain using a Visual Analog Scale (VAS) in which the maximum and minimum scores are 10 and 0 respectively. The degree of pain was recorded separately for the left and right joints. They will be further categorized into two groups: Group A (VAS score below 3) and Group B (VAS score above 3).

The subjects were placed on the table in supine position and Image receiving coils were arranged around the area of interest (grey matter and retro discal tissue). Patients were asked to maintain their anatomical dental occlusion to enhance alignment to the FLAIR MRI. The FLAIR MR imaging parameters was given [Table 1]. Sagittal images of FLAIR sequence were obtained and stored as DICOM files and signal intensities were determined by intact software in the system.

Table 1: MRI imaging parameters

Index	FLAIR images
TI/TR/TE/ETL	2500 ms/8000 ms/86 ms
FOV	240*240 mm
Section thickness	3 mm
Slice gap	0.3 mm
Matrix	256*256

Note: T1, inversion time; TR, repetition time; TE, echo time; ETL, echo train length; FOV, field of view

The signal intensity of Grey matter was considered as reference point. Both GM and retro discal tissue were included in the region of interest. The sizes and position of the ROIs were determined according to the method of Yajima et al.,[25] For each measurement, a 3 mm square ROI was placed over the retro discal tissue. A 6mm square ROI were drawn over the GM and placed closest to the mandibular condyle (Figure 1). Measurements of signal intensities in retro discal tissue is performed on FLAIR MRI images by two radiologist with more than 5 years of experience. The signal intensity ratios (SIRs) of retro discal tissue as calculated as follows

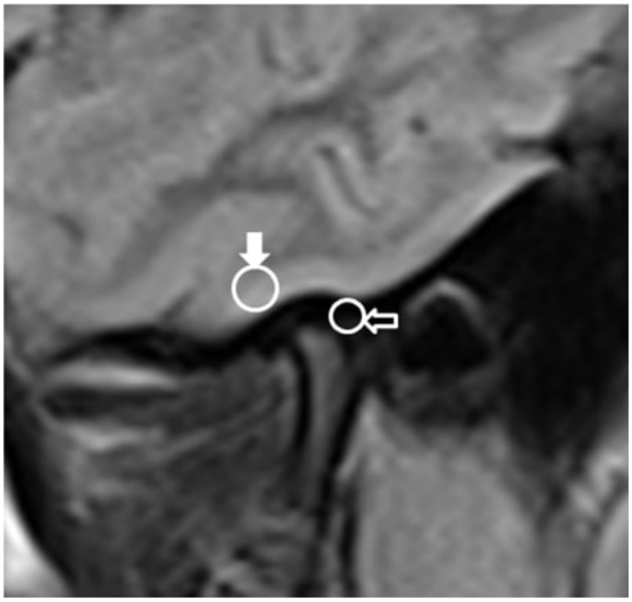


Fig. 1: Region of Interest on a FLAIR image in a closed mouth position. ROIs were placed over gray matter (white arrow) and ROIs for retro discal tissue were placed over the area just behind the disk (black arrow).

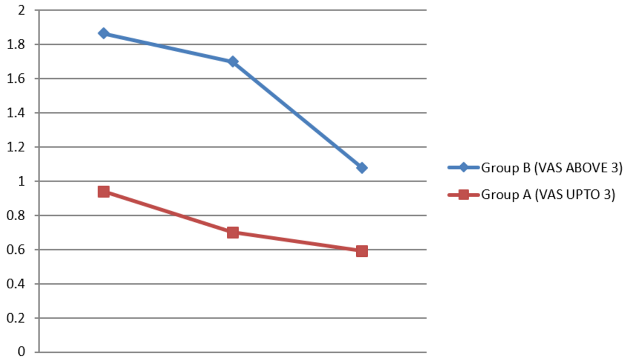
SIR = SIGNAL INTENSITY OF RETRODISCAL TISSUE / SIGNAL INTENSITY OF GM

MRI imaging was done with 1.5 T and the sagittal FLAIR images were compared between the painful and painless TMD joints.

The Normality tests, Kolmogorov-Smirnov and Shapiro-Wilks tests results reveal the study followed normal distribution. Therefore, to analyse the data, parametric test were applied. Unpaired t test was used to compare the mean values recorded for SIR included in the study. To analyse the data SPSS (IBM SPSS Statistics for Windows, Version 26.0, Armonk, NY: IBM Corp. Released 2019) is used. Significance level is fixed as 5% (α = 0.05). P-value <0.05 is considered to be statistically significant.

3 RESULTS

In this study, the population distribution found to be normal. Distribution of the population in the two groups according to age and sex were recorded. The mean age of patients in Group A and Group B were 34 and 33 respectively [Table 2]. Group A had higher female predilection and Group B had higher male predilection [Table 3]. Signal intensities in retrodical tissue region was measured in both the groups and the signal intensity ratios were calculated. The mean values of the signal intensity ratios in Group A and Group B were 0.9393 and 1.8659 [Table 4] . Group B patients showed increased Signal Intensity Ratios compared with Group A patient which was statistically significant. Therefore, patients with increased VAS score showed statistically significant increase in SIRs in posterior aspect of retro discal tissue [Table 5]. The mean difference between the two groups assessed by unpaired T test. In this, patients with increased VAS score showed statistically significant (p value=.006; Degree of freedom=31) increase in SIRs in posterior aspect of retro discal tissue [Table 5], [Graph 1].



Graph 1: Comparison of Mean, median and standard deviation difference of SIR between the study group

Table 2: Age distribution among the study groups

Age distribution (in years)	Group A (VAS UPTO 3)	Group B (VAS ABOVE 3)
21-30	41.1%	40%
31-40	17.6%	33.3%
41-50	41.3%	26.7%
Mean	34.7	33.8
Standard deviation	2.57	2.34

Table 3: Gender distribution among the study groups

Gender distribution	Group A (VAS UPTO 3)	Group B (VAS ABOVE 3)
Male	47%	66.6%
Female	53%	33.4%

Table 4: Descriptive statistics of the groups included in the study

Variable	Group A (VAS UPTO 3)	Group B (VAS ABOVE 3)
Mean	0.9393	1.8659
Std. Error of Mean	0.15292	0.26154
Median	0.7000	1.7000
Std. Deviation	0.59227	1.07834
Variance	0.351	1.163

Table 5: Comparison of mean difference of SIR between the study groups

	Variable					T	df	P value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Group A-Group B	-0.03719	1.30869	0.23135	-0.50902	0.43465	0.161	31	0.006

4 DISCUSSION

In this study, the study participants with a VAS score below 3 were categorized as group A and those above 3 as group B. The VAS scoring system is a subjective pain rating scale, introduced in the year 1921 by Hayes and Patterson.[26] Based on the age, the study participants were grouped as 21-30 years, 31-40 years and 41-50 years. In Group A, 41.1% of the participants were between the age range of 21 -30, 17.6% of the participants were between the age range of 31-40 and 41.3% of the participants were between the age range of 41-50. In group B, 40% of the participants were between the age ranges of 21-30, 33.3% of the study participants were between the age range of 31-40 and 26.7% of the study participants were between the age ranges of 41-50. The participants between the age of 21-30 years showed a higher VAS score compared to other two groups and the least score was noted in the participants in the age group of 31- 40. Considering the gender distribution among the 2 groups, group A had a higher percentage of females (53%) and group B had a higher percentage of males (66.6%).

Our study was directed to assess and to evaluate the correlation between the levels of pain in temporomandibular disorder patients with the amount of increase in the signal intensity in FLAIR MRI. This is the first study carried out in the Indian population to analyse FLAIR MRI relation with TMD patient's clinical pain score. Participants within the age group of 20 to 50 years who were diagnosed as having TMD based on TMD RDC criteria 2014 regulated by American Association of Orofacial Pain were enlisted in the study. The TMD Research Diagnostic criteria, first presented by Dworkin and LeResche in the year 1992,[27,28] was appraised as the most reliable and valuable etiology based diagnostic tool for clinical evaluation of TMD patients.

Kenichu Imoto et al (2011), conducted a study to compare the potential of fluid inversion recovery imaging with T2 weighed imaging in patients joint effusion. In this, FLAIR sequences revealed joint effusion containing presence of protein elements.[29] In the year 2013, Hitoshi hanyuda et al, clarified the presence of minimal amount of fluid in the temporomandibular disorder patients using FLAIR sequence and proposed that minimal fluid may contain proteinaceous elements that has the capacity to shorten T1 relaxation time in magnetic resonance images.[30] Following the next year, Sayaka kodama et al demonstrated that there is a relationship between the condylar bone marrow abnormalities in FLAIR images and the TMJ pain. This study also emphasized the advantage of FLAIR MRI over proton density weighed images and T2 weighed images.[24]

Migiwa kuroda et al (2015), revealed that there is significant increase in FLAIR MRI signal intensities in the retrodiscal tissue region in painful TMD patients. Also, this study underlined that the retrodiscal tissue in painful temporomandibular patients contains proteinaceous elements.[24] This same author after 2 years conducted a study and suggested that there is increase in signal intensity ratios in FLAIR MRI in the lateral pterygoid muscles in painful TMD patients.[31] Mika otonari – yamamoto et al (2017) emphasized that the FLAIR signal intensities can be influenced by the protein elements in joint effusion. Hence, it was concluded that diagnostic sensitivity is more in FLAIR images than T2 weighed images.[32]

Literature evidences quote the presence of elevated protein levels in painful TMD. These contents have the ability to shorten T1 relaxation time and is represented by an increased signal intensity in the FLAIR image. Some studies suggested that the retrodiscal tissue could be the origin of pain in temporomandibular disorders.[33] Therefore, retrodiscal tissue was considered as the region of interest in our study.

The mean difference of the Signal Intensity Ratios in the retrodiscal region were compared between group A and Group B. The mean difference is -.03719 and the standard deviation is 1.30869. It showed statistically significant differences (p value = 0.06). The higher values were noted among the study participants in Group B. The result of our study stated that there is increase in SIRs in TMD patients with higher clinical pain score. The results of our study is consistent with previous FLAIR MRI based studies.

This present study concludes that there is a significant correlation between the FLAIR MR signal intensity ratios and the clinical pain score. All the previous studies which have used FLAIR MRI to evaluate temporomandibular disorder symptoms were based on Japanese population. This is the first study done in the Indian population to evaluate the diagnostic efficacy of FLAIR MRI and its correlation with clinical TMD symptoms. From our study we observed that FLAIR MR images of retrodiscal tissue region could be helpful to objectify TMJ pain in the temporomandibular disorder patients.

The limitations of this study are smaller sample size and Visual Analog Scale is a subjective pain measuring tool so that this study required to be done with more efficient pain measuring method to objectify clinical TMD pain. In this study, we have performed MRI with 1.5 tesla and for improved sensitivity and specificity of the results and to formulate a diagnostic criteria, this study needed to be performed with MRI with 3.0 tesla.

Further multicentre studies with large sample size are needed to formulate a standard diagnostic criteria to evaluate TMJ pain in MR images.

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