Magnetic Resonance (MR) Abnormalities of the Lateral Pterygoid Muscle in Sideways and Rotational Disc Displacement of the Temporomandibular Joint

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Abstract

Objectives: The purpose of this study was to assess the magnetic resonance (MR) changes in the lateral pterygoid muscle (LPM) in cases of sideways (lateral or medial) and rotational (antero-lateral and antero-medial) disc displacement of the Temporomandibular joint (TMJ).

Methods: A quantitative analysis of randomly selected MRI images of 61 patients over a period of six months was carried out who had either bilaterally normal TMJs or had rotational and/or sideways components of the disc displacement. Area and signal intensity of superior head (SLPM) and inferior head (ILPM) of lateral pterygoid muscle of normal and disc displaced muscle was noted and compared. Statistical analysis was carried out using Wilcoxon signed ranks test to determine difference between different muscle pairs.

Results: Area of the muscle of normal subjects was higher from all the other subjects. This was followed by the muscle area of tethered discs which was then followed by sideways, rotational and anteriorly displaced discs. Signal intensity of the SLPM of normal subjects was highest among the rest followed closely by anteromedial, anterolateral and anterior disc displacements, tethered discs, lateral and medially displaced discs. Relatively same pattern was seen in the ILPM. Statistical analysis showed that there were highly significant differences between different muscle pairs in their area and signal intensity.

Conclusion: Abnormalities of both heads of lateral pterygoid muscle were seen in different disc placement individuals. Muscles associated with rotational and anterior disc displacement had higher signal intensity depicting any oedematous change in the muscle.

Keywords: Temporomandibular joint disorders, magnetic resonance imaging, temporomandibular joint disc, pterygoid muscles, facial muscles.

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Introduction

The temporomandibular joint (TMJ) is the region where condyle of the mandible makes an articulation with the base of the skull. The importance of this joint is many folds as it helps human beings in performing different functional and Para-functional movements e.g. speaking, eating, chewing, clenching, etc. It is because of this importance that a lot of research has been done in last decades to understand its anatomy, structural attachments, function, and disorders. The disorders of this joint are quite common. These disorders are quite diverse, and their prevalence varies among different populations. However, all studies that have been done on TMJ disorders (TMJD) suggest that these disorders are more common in females as compared to males and approximately 7 out of 100 people are affected by TMJ disorders worldwide.

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After its invention[1] in 1974, magnetic resonance imaging (MRI), in recent years, has gained significance in detecting and diagnosing soft tissue abnormalities of the human body. Its role in dentistry has also become more important in the last few decades. It has achieved a lot of success in effectively diagnosing TMJD especially the displacement of the disc. It has also helped in finding the aetiology of the TMJD and thus has helped in devising effective treatment options for the TMJD. Magnetic resonance (MR) images give an actual depiction of the normal and abnormal TMJs[2] and also has superiority to other radiographic techniques in demonstrating the disc position[3-8]. Therefore, it is termed as the method of choice for diagnosing internal derangements of the TMJ. MRI provides excellent soft tissue details and more readily demonstrates medial and lateral disc displacements as compared to other radiographic techniques[9]. Its accuracy with respect to disc position[9] may reach 95% and has 83% accuracy in diagnosing sideways and rotational disc displacements[10]. Proton density (PD) and T2-weighted images are more useful than T1-weighted images in the diagnosis of disc status[11]. Therefore, T2-weighted gradient echo (GE) sequences are used in this study for the evaluation of lateral pterygoid muscle.

The role of lateral pterygoid muscle in the development of TMJ disc displacement has recently been highlighted by many authors[9,12-17] and this has led to much research for the pur-pose of finding its relationship with the TMJ disc displacement. Initially, some studies were done on cadavers to check for this relation, but development of MRI has created a new dimension for this research as now we can analyse the joint in dynamic states which initially was not possible with the cadavers.

A lot of work has been done to check the role of lateral pterygoid muscle in the development of anterior disc displacement, but no one has ever checked its role in the development of sideways i.e. medial and lateral, and rotational i.e. anteromedial and anterolateral components of the disc displacement. This particular aspect will be covered in this study and the results will be analysed in detail to find any significant relationship between the lateral pterygoid muscle and the sideways and rotational components of the disc displacement and to see how this muscle behaves in these disc displacements, what are the changes that occur in the muscle and what are the signals that muscle gives during these conditions.

Material and Methods

A retrospective review of dedicated 61 TMJ MRI reports and images taken over a period of 2 years was done for the extraction of bilaterally normal subjects and for patients with lateral disc displacement, medial disc displacement, antero lateral disc displacement, antero medial disc displacement, Anterior disc displacement and degenerated/tethered discs. All these dedicated reports were saved on institution's Picture Archiving and Communication (PAC) system database and were authorised by a consultant radiologist of the Multan Medical and Dental College, Multan. A total of 14 bilaterally normal symptomatic patients were randomly selected irrespective of their age, sex and race. A total of 122 TMJs and their MRIs taken from 61 patients were examined for this study. Out of these 61 patients, 15 were male and 46 were females. Out of 122 TMJs used for this study, 28 were normal joints, 5 had medial, 18 had lateral, 28 had anterolateral, and 12 had anteromedial disc displacement. 13 joints with tethered discs were also selected and 18 joints with which had anterior disc displacement on one side and sideways and/or rotational disc displacement on the other side were also included in the study to see any relationship between them. All these cases were reported by a consultant radiologist and were authorised as well. The age range of patients was 15-69 years. T2* weighted images were selected for this study and prospective measurements were made to measure separately the area of superior head (SLPM) and inferior head (ILPM) of the lateral pterygoid muscle and its signal intensity. A database was created and statistical analysis was done using the Statistical Package for the Social Sciences (SPSS version 12.01 Inc. Chicago, USA)

Patients having history of joint surgery, arthritis, osteophyte formation were excluded from the study. Patients having sideways and rotational disc displacement scanned on different imaging sequences were also excluded from the study. Some

MRI images were to be excluded because of their compromised image quality.

The MRI scans were carried out at the Multan Medical and Dental College, Hospital. Every patient was briefed about the nature of the examination and they were required to fill a questionnaire in order to assess their suitability and safety for the scan. They were also told about the potential hazards and contra indications of MRI. Their formal consent was also taken. Patients with metal implants, prosthetic heart valves, pace makers were first discussed with consultant radiologists to assess their safety.

For this particular study, we used scans that were performed on a GE Signa 1.5 T magnet (GE Healthcare, Milwaukee, Wisconsin) machine using sagittal oblique T2* weighted imaging sequences. After selecting the right images and extracting the right subjects, measurements were taken on the MR image analysing machines. Area and its corresponding signal intensity of the superior head of lateral pterygoid muscle (SLPM) and inferior head of the lateral pterygoid muscle (ILPM) were taken and noted down. Patient number was not recorded because of ethical requirements. All these measurements were taken carefully to avoid any false readings. To calculate the area, points were put carefully along margins of respective heads of the muscle. Points for the signal intensity were also put along the same area line (See Fig. 1). Patient's gender, age, diagnosis, area in mm^2 and minimum/maximum values together with their mean and deviation for signal intensity were noted manually on a custom-made sheet. All these values were plotted on Microsoft excel sheets and their relationship to each other was determined using charts and graphs.

We used a non-parametric 2-tailed Wilcoxon Signed Ranks test using Statistical Package for the Social Sciences (SPSS version 12.0.1 Inc. Chicago, USA) programmed to compare bilaterally normal subjects with disc displacement patients and to compare disc displacement patients with each other in order to find any statistically significant differences. Differences in area and signal intensity of superior heads of the 2 lateral pterygoid muscles were used for the comparison and the same procedure was adopted for inferior heads. Significance for this study was defined as a p-value<0.05. A p-value <0.01 was defined as highly significant.

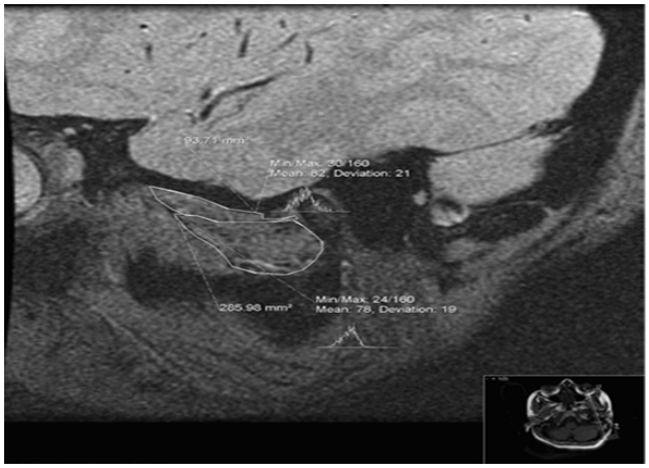

Fig. 1. Measurements on Magnetic Resonance Image (MRI)[18]

Results

In this particular study, area of the muscle of normal subjects was higher from all the other subjects. This was followed by the muscle area of tethered discs which was then followed by muscle area of the sideways displaced discs. Muscle area for the rotational and anteriorly displaced discs was smaller than rest of the group. The same trend was seen in the inferior head except for the muscle of medially displaced discs whose area was the smallest (Fig 2 and 3).

Results for the signal intensity of the SLPM show that although muscle areas for the rotational and anteriorly displaced discs were smaller than rest of the group, their signal intensity was considerably higher. The signal intensity of muscle of normal subjects was the highest among the rest followed closely by anteromedial, anterolateral and anterior disc displacement. The signal intensity of SLPM of tethered discs, lateral and medially displaced discs were considerably lower as compared to their area which was relatively higher. Relatively same pattern was seen in the ILPM where signal intensities of rotational and anteriorly displaced disc muscles were second higher after normal subjects and lateral and medially displaced muscles had lowest signal intensities. Statistical analysis showed that there were highly significant differences between different muscle pairs in their area and signal intensity. Comparison of area and signal for both

heads of lateral pterygoid muscle can be in the graphs below.

Discussion

The aim and objective of this particular study was to find a relationship between the lateral pterygoid muscle and the sideways and rotational components of the disc displacement. Much work in past has been done in finding the relation between lateral pterygoid muscle and anterior disc displacement but no one has ever postulated this relation for the sideways and/or rotational disc displacement. This was the primary motive behind this study.

Tasaki et al[19] gave a possible aetiology of TMJD with regards to lateral pterygoid muscle. Their study was based on two principles. The first principle was to check the role of muscle attachment in the development of disc displacement and the second was to check the influence of muscle atrophy on disc displacement. They concluded that there was no significant differencebetween the muscle attachment and presence/absence of disc displacement. This was the reason that muscle attachment was not included in this study. The other thing that they found was a statistically significant difference between the normal and anterior disc displacement cases based on muscle atrophy i.e. muscle atrophy was present in anteriorly displaced disc muscles. They only checked this importance for anterior disc displacement and did not pay any heed on sideways and rotational components of disc displacement which has been done in this study.

In this study, muscle atrophy was present in lateral pterygoid muscle associated with side-ways and rotational disc displacement of the TMJ. These changes were more prominent in superior head of the lateral pterygoid muscle (SLPM). These findings support to what Tasaki et al found in their study. They found that there was more involvement of the superior head in anterior disc displacement. After statistical analysis we found that there were almost equal statistically significant differences between normal subjects and disc displaced cases in ILPM and in SLPM. This shows that there is some involvement of ILPM in the development of sideways and rotational disc displacement.

Another study was done by Finden et al[12] in which they noted the pathological changes of the lateral pterygoid muscle in patients with TMJ disc displacement by doing objective measurements at MR imaging. They measured absolute thickness of the muscle and signal intensity of the mid portion of the muscle which they termed as the "region of interest". They found that there was significant increase in signal intensity of the lateral pterygoid muscle of anteriorly displaced discs as compared to normal ones.

In this study although normal subjects had the highest signal intensity of all the groups, there was significant increase in the signal intensity of muscle associated with rotational disc displacement as compared to their area which was far less than normal subjects. There can be many reasons for this. They measured the signal intensity of only mid portion of the muscle which they termed as their "region of interest". These measurements were not true depiction of the whole muscle but of a small area. However, in this study measurements were done on the whole thickness of the muscle and the results were slightly different. Radiographically bilateral normal yet symptomatic subjects were taken for this study as they were taken by them and found that they had largest area and highest signal intensity. There was an increase in the signal intensity of rotational and anterior disc displacements which support their study. Area to signal intensity ratio in muscle with lateral and medial disc displacement was very low as compared to rest of the group. Their area was larger than anterior and rotational disc displacement but their signal intensity was much lower.

Yang X et al.[20] did a similar study to find MR abnormalities of the lateral pterygoid muscle in patients with non-reducing TMJ disc displacement. Their findings were also in accordance with findings of this study as they found that pathological changes were more prominent in the superior belly of the lateral pterygoid muscle (SLPM). But their study was limited to find abnormalities in patients with non-reducing disk displacement. This study also suggested that there were more pathological

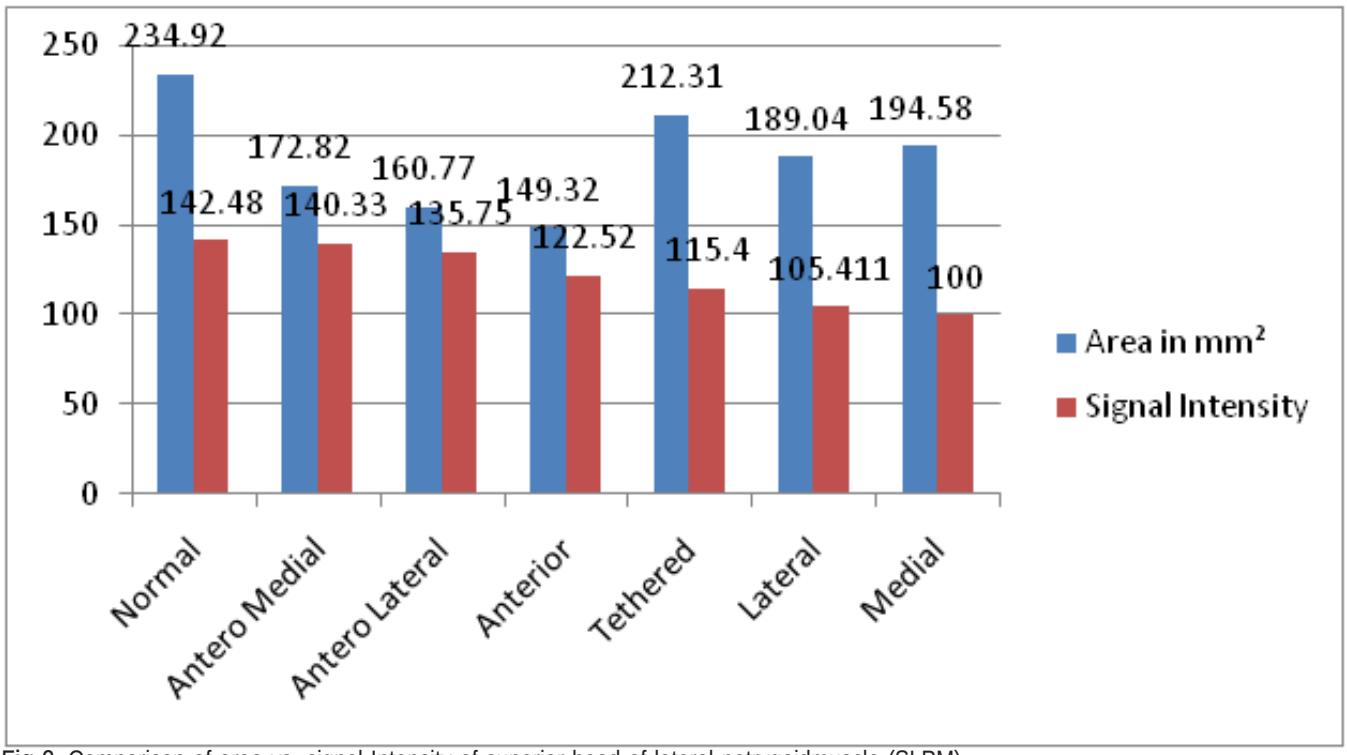

Fig 2. Comparison of area vs. signal Intensity of superior head of lateral petrygoidmuscle (SLPM)

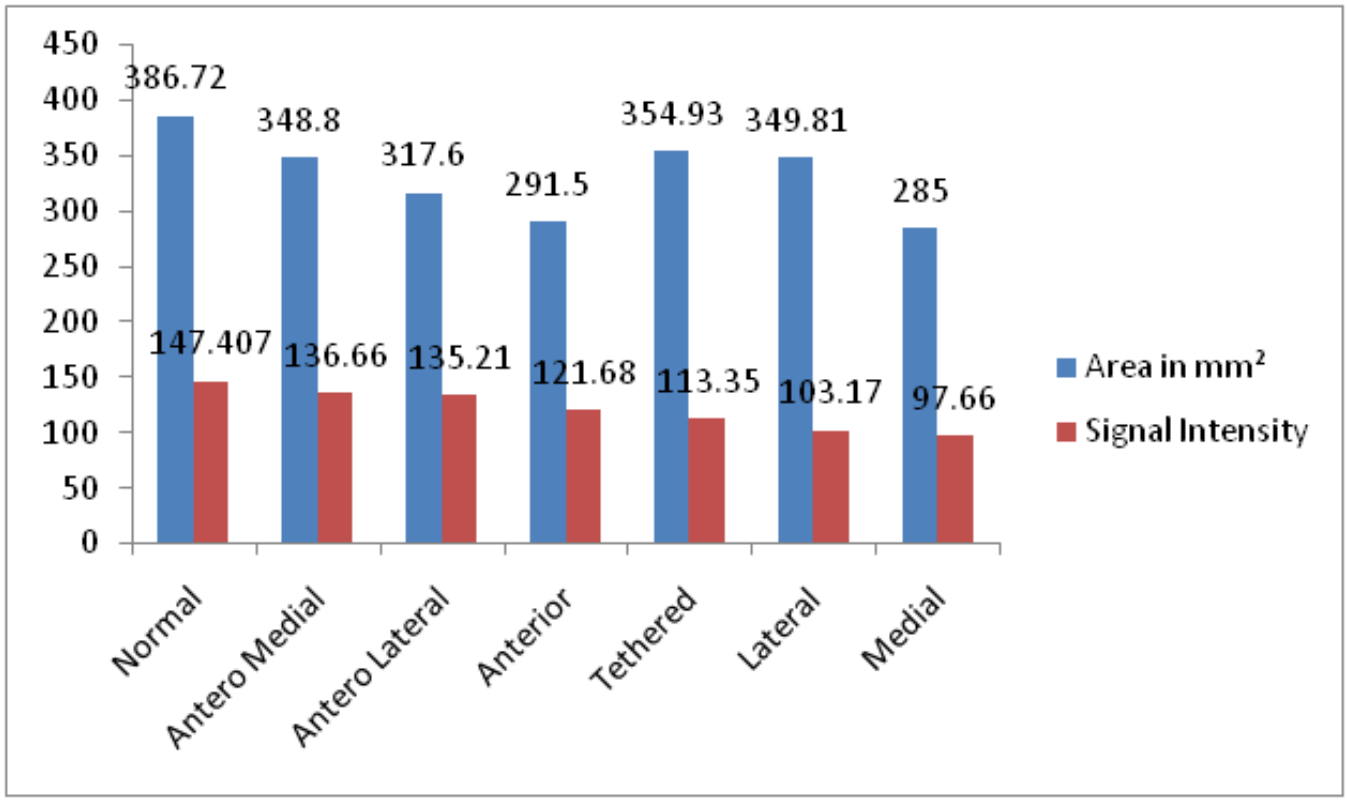

Fig 3. Comparison of area vs. signal intensity of inferior head of lateral pterygoid muscle (ILPM)

changes associated with the superior belly (SLPM) in patients with sideways and rotational components of the disc displacement and even in patients who had anterior disc displacement on one side and sideways and/or rotational components of the disc displacement on other side. These findings were present in general and were independent of the reduction mechanism of the disc. Another important finding revealed by this study was that whenever there was anterior component of the disc displacement involved, there was increased signal intensity. Similar pattern was observed in muscles with rotational disc displacements i.e. anteromedial and anterolateral disc displacements.

A limitation of the study was that all the patients who were evaluated for this study were symptomatic and were referred for the scan because of their symptoms. Hence, the normal group of patients selected for this particular study was radiographically normal, but they had symptoms of TMJD. Furthermore, they were not scanned for research purpose. These patients may have some potential for future disc displacement thus giving false results or may had some muscular pathologies that made them symptomatic. Another limitation which is important in determining the path of the whole research was the limited number of patients that were extracted for this particular research. There was limitation of the frequency of condition as sideways and rotational disc displacements of the TMJ are quite rare and these were the only patients available on institution's PACS system therefore this study was restricted to a smaller sample size. Another limitation of the study was that size of the groups was not equal because of limited number of available patients. Results would have been much better with equal number of patients in each group.

Another limitation of this study was poor image quality of some scans which were left out thus making the size of the sample further smaller. Some examples of compromised images are mentioned below in which lateral pterygoid muscle has poorly defined boundaries.

Many authors have written about the efficacy of MRI in diagnosing disc displacement cases. All had a mutual agreement that it is the most useful tool in diagnosing soft tissue abnormalities. But there are some individual variations that need to be addressed. The most important of these is the placement of slice at the time of MR scan. A slight error in the placement of slice can variably change the results and make them misleading (see Fig. 4).

Another important thing required for the image analysis is correct measurement of the area. Area

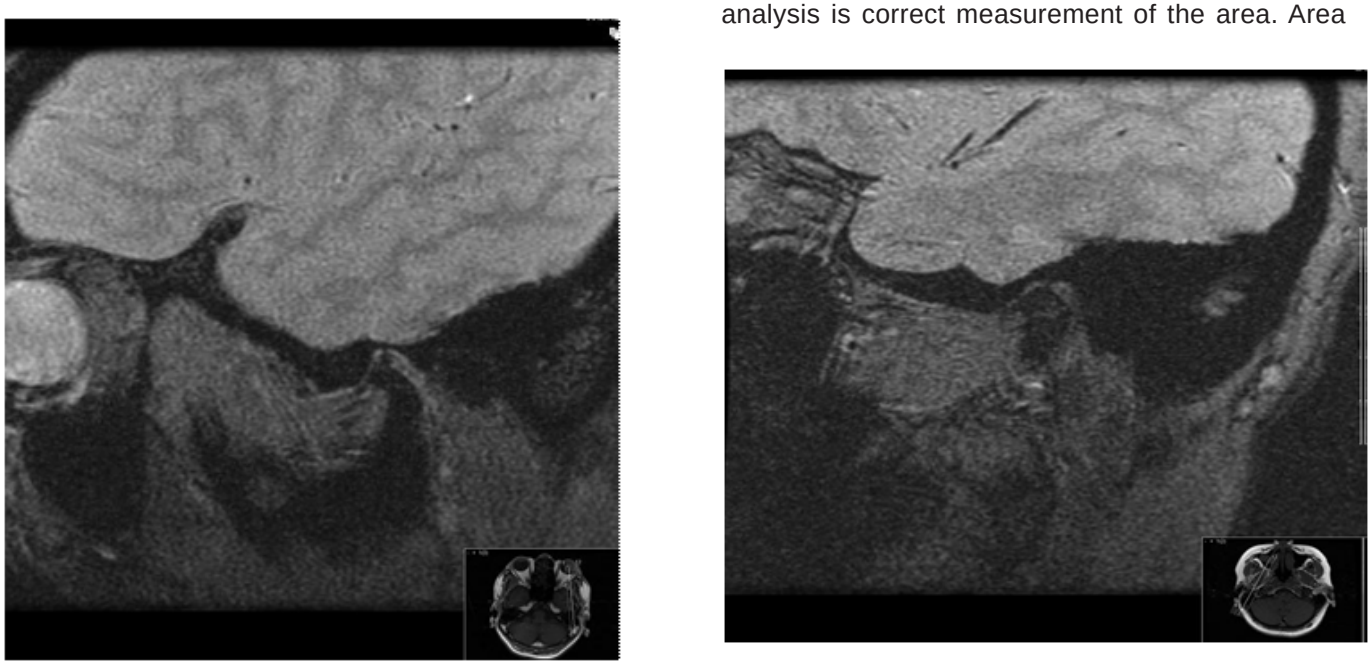

Fig. 4. Images with poor quality and incomplete information

of the lateral pterygoid muscle on MR image is measured by putting small points along its margins and then joining them. Understanding of the muscle and its surrounding structure anatomy is very important in this analysis as structures may become enmeshed up on some images and putting the points in wrong direction may lead to abnormal results and make them misleading.

Schmitter et al[3] postulated that two important factors affect the reliability and validity of imaging diagnosis. The first one is diagnostic accuracy of the technique (which is discussed above) and the second one is performance of the examiner. Both of these factors play a significant role in making correct diagnosis.

Westesson[21] conducted a study on the reliability and viability of imaging diagnosis of TMJD. He assessed the images on four different grounds: (a) accuracy of the image findings; (b) consistency of the image when several images of the same morphology are taken over time; (c) consistency of the observer; (d) relevance of the patient's symptomatology to the image findings. He concluded that there was 95% intra-observer agreement and 91% inter-observer agreement for the detection of disc position through MR images.

Recently, a study was done by Butzke et al.[22] on the evaluation of the reproducibility in the interpretation of magnetic resonance images of the TMJ. 9 experienced and trained observers examined 30 different images of the TMJ at 2 different times. They concluded that examiners do not demonstrate reproducibility in the interpretation of TMJ MR Images, i.e. the observations can be slightly different when the same image is viewed by the same examiner at two different times, except for the disc displacement cases in which there was substantial agreement between various groups of examiners.

All these criteria were closely monitored before the commencement of the study. All the images taken for this study were reported and authorised by 2 different consultant radiologists who had complete harmony in their decisions. Hence, the element of intra examiner agreement was taken into consideration. All the images for this particular study were selected by a consultant radiologist, a clinical lecturer and a post graduate student and they all gave their consent for the images and best images were selected. This was the main reason that many images were left out because of their compromised quality due to incorrect slice positioning, in correct level positioning, artefacts etc. Thus, the element of variable signal intensity was eliminated.

Another important criterion was positioning of points along margins of the muscle. This was also done under supervision and points were very carefully and precisely marked. Points for the measurement of signal intensity were also marked along the area line, thus eliminating any chances of calculating area and signal intensity that were not corresponding.

T2 weighted images were selected for this study and results were formulated according to measurements taken on these images. Abnormalities of the both heads of lateral pterygoid muscle were seen in different disc displacement individuals. On these images, fluids have the highest signal intensity followed by water based and fat based tissues which have lower signal intensity. Muscles associated with rotational and anterior disc displacement had higher signal intensity as compared to their area depicting any accumulation of fluid or oedematous change in the muscle. This study also showed that whenever there was anterior component of the disc displacement present, there was increased signal intensity. Tethered, medial and lateral disc displacements had lowest signal intensity depicting some fat deposition in the muscle associated with these disc displacements. All these results clearly show the involvement of LPM in these disc displacements.

Many new aspects of sideways and rotational disc displacements are highlighted in this study which were never discussed in any literature. This study will pave the way for future research on these rare disc displacements. A more comprehensive work needs to be done on this topic. Instead of normal symptomatic subjects, asymptomatic volunteers should be scanned in future to act as a better control of the study. Database should be extended in order to increase the availability of these rare disc displacement images. Better images can also be extracted if one has a larger data base.

Conclusion

Abnormalities of both heads of lateral pterygoid muscle were seen in different disc displacement individuals. Muscles associated with rotational and anterior disc displacement had higher signal intensity depicting any oedematous change in the

muscle. Tethered, medial and lateral disc displacements had lowest signal intensity. All these results clearly show the involvement of LPM in rotational and sideways temporomandibular joint disc displacement.

Conflict of Interest

Authors have no conflict of interests and no grant/funding from any organisation for this study.

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