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ULTRASONOGRAPHY - AN IMAGING MODALITY FOR TEMPOROMANDIBULAR DISORDERS

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ABSTRACT

Ultrasonography is a reliable imaging modality when imaging soft tissues. This review aims at highlighting the use of ultrasound in TMD diagnosis. Diagnosis is the key to a proper treatment plan. With the increasing prevalence of TMD using imaging modality that is inexpensive and reliable is the need of the hour.

INTRODUCTION

The temporomandibular joint (TMJ) is a composite ginglymus-arthrodial joint that is composed of the condyle, glenoid fossa, articular tubercle, articular disc, retrodiscal tissue, synovial membrane, and joint capsule.1 Temporomandibular joint disorders (TMD) constitute structural and/ or functional disorders that affect TMJ, masticatory muscles and related structures. . In 2014, Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), clearly defined the different internal derangement conditions. According to RDC/TMD, two different degrees of displacement of the disc relative to the condyle exist: disc displacement with reduction and disc displacement without reduction [7].

These disorders may present with clinical signs such as articular noises, TMJ pain and/or limitation in opening and closing mouth2. These disorders affect the quality of life, having a prevalence of 10% to 70% in the population. . Clinical studies usually report a greater incidence of TMJ dysfunction in females, especially in women who are 20 to 40-year-old3. Diagnosis is important in the evaluation and managing the disease effectively. In the last two decades, several techniques have been described in the literature to assess bony and soft TMJ tissues4 . . MRI is described as the gold standard in the literature5. Low availability, long time requirement, and high cost preclude its routine use. In addition, MR is contraindicated for patients with claustrophobia, pacemaker and metal prosthesis6. So it becomes necessary to find an alternate modality of imaging which can overcome the limitations of MRI and at the same time be reliable. Ultrasound on the other hand is less expensive, easily accessible, imaging takes less time and gives a real time imaging of the joint. The only disadvantage being it is technique sensitive. Visualization of the TMJ and disc with USI was first reported by Nabeih and Speculand with a 3.5-MHz transducer in 19917. In 1992, Stefanoff et al., evaluated the TMJ disc in asymptomatic volunteers with a 5-MHz transducer and reported successful results8. However the use of ultrasonography for the diagnosis of temporomandibular joint (TMJ) disorders is rare although previous studies suggest USG imaging to be comparable with MRI imaging.

The present review aims at highlighting the use of USG in TMJ imaging and the diagnostic reliability of the same.

Ultrasonography principal

The principle of ultrasonography is based on the fact that ultrasonic sound waves emitted by a device (transducer), travel through TMJ, and are partly reflected on transiting through dissimilar anatomical structures. The reflected sound waves are then read by the same emitting device and are translated into images9. The transducers range from 5-14MHz.The TMJ region consists of diffrent structures that reflect sound waves differently. Bone tissue, represented by the head of the condyle and the articular eminence, is generally hypoechoic (low reflection of sound waves) and appears black in ultrasonography images, however the margin of the bone is hyperechoic (high reflection of sound waves) and appears white in ultrasonography images. Connective tissue, represented by the joint capsule and the retrodiscal tissue, and muscular tissue, represented by the lateral pterygoid and masseter muscles, are isoechoic (intermediate reflection of sound waves) and appear heterogeneously grey in ultrasonography images. However the surface of the joint capsule, as well as the surface of the muscles, highly reflect the sound waves generating a hyperechoic (white) line. Empty space and water, like the superior and inferior joint spaces, are hypoechoic and appear black in ultrasonography images, however, these anatomic cavities are virtual because the opposing surfaces are in contact, and usually not detectable, unless effusion is present.10 The articular disc may appear iso to hypoechoic. , joint capsule, pterygoid muscle and retrodiscal tissues all appeared as isoechoic.

Patient position

Patient can be in a sitting or in an lying down position . when patient in lying down position he is lying supine with the jaw tilted away from the side to be examined, as this position not only offers more stability for probe positioning but also allows for further patient comfort. The joint is then palpated while we have the patient open and close their mouth. Once the joint is located, the probe is placed over the joint using a liberal amount of warm gel. Traditional ultrasound techniques have included positioning of the probe on the skin surface in the axial and coronal planes11,12. When obtaining closed mouth ultrasound images, transducer is placed transversally and positioned parallel to the zygomatic arc and Frankfurt plane and perpendicular to ramus. When obtaining open mouth ultrasound images, transducer is positioned transversally with a 60° 70° angle to the Frankfurt plane. The operator constantly adjusts the position of the transducer during condylar translation from closed mouth position to open mouth position for better visibility of the disc. Real-time movement can be visualized for the assessment of disc displacement whereas static images can be utilized for conducting ultrasound measurements[13].

Interpretation of TMJ disorders

Visualizing the TMJ using USG is challenging, The difficulty in visualizing the TMJ using ultrasound contributes to the limited accessibility of the deep structures, especially the disc, due to the absorption of sound waves by the lateral portion of the head of the condyle and the zygomatic process of the temporal bone[14].

Articular disc position can be assessed in transversal plane in both closed and open mouth situation. For open mouth ultrasound images, articular disc was considered as normal if it was located superior to condyle, whereas anterior disc

displacement is considered if the disc was positioned anterior to mandibular condyle. For closed mouth ultrasound images, articular disc was considered as normal if it was located between condyle and articular eminence, whereas anterior disc displacement can be considered if the disc is positioned anterior to mandibular condyle and inferior to articular eminence. Medial displacement can be considered when the disc boundary shifted medial to boundary of the condyle and laterally displaced when the disc boundary shifted lateral in comparison to the boundary of the condyle[15]

Joint effusion - Both in transversal and longitudinal transducer positions synovial fluid increase in TMJ space can be assessed. In transversal position, for closed mouth measurement, distance between mandibular condyle and glenoid fossa is measured at three points twice and the highest value can be recorded, whereas, for open mouth measurement, distance between posterior articular eminence and mandibular condyle can be measured at three points twice and the highest value is recorded values higher than 1.76 mm can be considered as an increase in synovial fluid thickness leading to TMJ effusion16.22 In longitudinal position, in both closed and open mouth positions, distance between TMJ capsule and lateral pole of the mandibular condyle can be measured at three points twice and the highest value can be recorded, thereby; the effect of synovial fluid increase in the space between capsule and mandibular condyle can be determined13.

DISCUSSION

The present review describes ultrasonography as a quite sensitive and useful imaging technique in the diagnosis of TMJ disorders. It is non-invasive, inexpensiveness, easily available and less time-consuming. However literature provides a diverse view on the sensitivity and specificity of USG in comparison to MRI. We would like to highlight the diagnostic accuracy of USG in the diagnoses of disc displacement and joint effusion imaging.

Sensitivity is found to be directly proportional to the resolution of the transducer used. Increase in resolution increased the sensitivity of USG. Emshoff et al., used a transducer of 7.5 MHz, with which the sensitivity was found to be 41-50% and specificity was 70%17. Habashi et al. used transducer of 5- 17 MHz frequency the sensitivity was 74.3% and specificity was 84.2%[18].

As the imaging requires the patient to open and close the mouth it has been noticed that a. significant differences were seen in the values of sensitivity, specificity, diagnostic accuracy in closed and open mouth positions. In the study of Emshoff et al., sensitivity was found to decrease from closed to open mouth position, while specificity increased from closed to open mouth position17. Diagnostic accuracy was more in the open mouth rather than closed mouth position, but in both the positions, the results obtained were acceptable. In a study of Mello Jr CF et al., sensitivity was as high as 83.3% in closed mouth position, but it was low in open mouth position19. The position of the transducer also varied from horizontal (parallel to the zygomatic arc) to vertical (parallel to the ramus of the mandible),20,21,22 the sensitivity ranged from 75% - 90%, and specificity was in the range of 76%- 85% which can be attributed to different images of the TMJ in a transverse or a coronal/sagittal plane. The imaging of the disc can range from hypoechoic to isoechoic band as seen in the study by Byahatti et al23.Sometimes the band may appear as a hyperechoic band as seen in the study by Emhoff et al. this can be attributed to the different structures and the position of the patient and the transducer during examination. Many studies have showed that the diagnostic accuracy is good when imaging for disc displacement and joint effusion. In a study by Dilek Yılmaz et al the usg image was compared to the gold standard MRI and it was showed excellent correlation between the ultrasound and MRI images. In a meta analysis done by Tomasz Klatkiewicz et al concluded that high-frequency ultrasound to be promising, both due to technological advances that provide increasingly more powerful transducers as well as some of the findings of research conducted so far. However, all the knowledge acquired to date needs to be unified and standardized, and further research is required that should involve both normal and abnormal joints.24the limitations of USG is the difficulty in visualizing the disc, it is technique sensitive and depends on the operator skills. Only the lateral part of the joint can be visualized so conditions like medial disc displacement can be missed.

CONCLUSION

Ultrasound a non-invasive modality of imaging it can be used in imaging the disc displacement and joint effusion. It is advantageous over MRI with its less cost and can be used in cases where MRI is contraindicated.it has good sensitivity and specialty making it reliable. Making it a reliable modality of imaging of the tmj disorders.

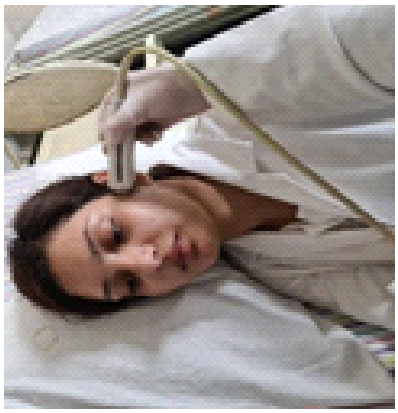

Fig 1. Probe placement in closed mouth

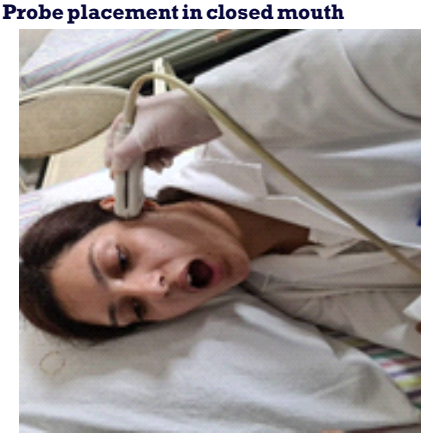

Fig 2 probe placement in open mouth

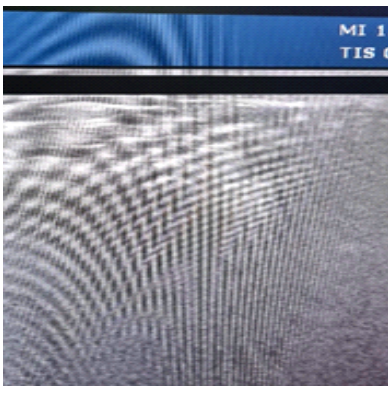

Fig3 closed mouth

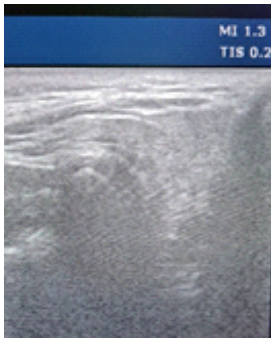

Fig4 open mouth

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