The Role of Ultrasound in Diagnosis of Temporomandibular Joint Disc Displacement: A Case–Control Study

U. Siva Kalyan¹ · Kishore Moturi² · K. Padma Rayalu²

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Abstract

Purpose Ultrasound is extensively being used for imaging of temporomandibular joint as it is non-invasive and relatively inexpensive. The purpose of this study was to evaluate the use of ultrasound in identifying TMJ with internal derangement and to access its usefulness as a diagnostic tool in patients with TMJ clicking.

Methods A case–control study was done: 25 patients with a complaint of clicking sound while opening the jaw were randomly selected as the study group and 25 patients who were asymptomatic on TMJ examination were selected as the control group. Both the groups were subjected to bilateral ultrasound scanning of the TMJ. The lateral part of capsule to condyle distance (LCCD) and the anterior part of capsule to condyle distance (ACCD) were measured.

Results The mean LCCD of all the 50 joints in the control group was 1.3630 mm, and the mean ACCD of the 50 joints was 1.4850 mm. These values were compared with each of the 50 symptomatic joints scanned in the study group. It was noted that 56% of the subjects showed deviation towards right side and 44% showed deviation towards right side. Clicking was heard in all the subjects while opening the mouth on auscultation. The frequency and percentage distribution of negative and non-negative deviations of LCCD from that of control group were noted. In total, 40% showed negative deviation and 60% showed

non-negative deviation. In total, 24% of the subjects showed negative deviation and 76% showed non-negative 190 deviation of ACCD when compared with the control group. T test shows that with respect to LCCD measurement there is no significant difference between symptomatic and asymptomatic subjects, whereas ACCD measurements are significantly different between the symptomatic and asymptomatic subjects.

Conclusions Hence, it can be concluded that auscultation is mandatory in the examination of temporomandibular joint for clicking sound. Ultrasonography, which has shown high specificity, can supplement clinical evaluation in patients with TMJ disorders and can be used as a potential diagnostic tool for identifying internal derangement of the temporomandibular joint with reduction.

Keywords Ultrasonography · Temporomandibular joint · Internal derangement

Introduction

The temporomandibular joint (TMJ) is a unique joint as it is the only movable joint in the craniofacial region. The joints on both sides function simultaneously, and it is the only synovial joint in the human body apart from the sternoclavicular joint with an articular disc [1].

TMJ problems present with many symptoms which aid in their diagnosis, but articular disc displacement may present without symptoms. Hence, a good diagnostic modality is required to identify this progressive condition while causing minimal harm to the patient.

Studies on condylar motion have used direct measurements using axiography, kinesiographs, photocells and light-emitting diodes which did not give satisfactory

✉ U. Siva Kalyan
sivkalyan@gmail.com

¹ Department of Oral and Maxillofacial Surgery, GITAM Dental College and Hospital, Visakhapatnam, India

² Department of Oral and Maxillofacial Surgery, Vishnu Dental College and Hospital, Bhimavaram, India

results. Imaging techniques that include direct viewing via X-rays, arthroscopy MRI were also used. The main disadvantage of X-rays is that they provide a static view while exposing the surrounding structures to radiation. Arthroscopy involves surgical invasion of the joint with abundant surgical risks as well as the significant likelihood of altering normal function by its presence [2]. Magnetic resonance imaging is the reference standard for imaging techniques for the visualization of the temporomandibular joint. MRI, however, cannot be carried out in some patients (those with pacemakers, claustrophobics), and its use is limited by its cost and the time it takes [3]. The patient's head position in MRI is abnormal, which can influence mandibular motion. It is a costly procedure and often requires the patient to travel to a special facility [4].

The need has arisen for alternative radiological techniques that have good diagnostic accuracy and reliability and are inexpensive, quick and not invasive [5–7]. Ultrasound imaging is one such simple tool that has been recognized for some time as having several important advantages it does not require special facilities and thus has the potential to become available in a dental office, and it can be used to view the joint in a continuum without invasion, discomfort, alteration of the patient's normal head posture or interference with condylar motion.

Audio frequencies greater than 1600 Hz (cycles per second) are considered ultrasonic. An ultrasonic sound wave passing through tissue will have a portion of the sound wave reflected on transiting dissimilar tissues. This reflected energy returns to the ultrasonic emitting device (transducer) where the location of the interface is determined, and an appropriate image is produced representing the interface contours. In the last decade, ultrasonography has been used as a new method for diagnosing TMJ disc displacement. TMJ ultrasonography is a non-invasive readily available and relatively inexpensive dynamic “real-time” examination, featuring soft joint tissues. It serves both for diagnosis and differential diagnosis and for the comparison of therapeutic results in treating internal joint defects [4].

Further research in this imaging modality for the TMJ is needed because ultrasonography offers many advantages, including reduced cost, accessibility, fast results, decreased examination time and lack of radiation exposure. Taking into consideration the advantages ultrasonography possesses over the other diagnostic aids, the present study has been done to evaluate its use in TMJ imaging.

Aims and Objectives

1. To study the role of ultrasound in normal TMJ.
2. To determine the distance between the articular capsule and mandibular condyle (which indicate space

occupied by the disc) in asymptomatic patients using ultrasound.

3. To determine the distance between the articular capsule and mandibular condyle in patients presenting to us with TMJ clicking sound, using ultrasound.
4. To evaluate the use of ultrasound in the study of TMJ with internal derangement.

Materials and Methods

Patients reporting to Vishnu Dental College, Bhimavaram, Andhra Pradesh, India, were included in the study. A sample consisting of 50 joints which were asymptomatic on TMJ examination was included in the control group, and that consisting of 50 joints which were clinically diagnosed with clicking sound was included in the study group. Informed consent was taken from all the subjects.

Inclusion Criteria

- Patients with clicking sounds in TMJ examination were considered in the study.

Exclusion Criteria

- Subjects with complete loss of posterior teeth.
- Subjects with severe malocclusions (malocclusions such as openbite, crossbite, deepbite, angles class II, class III molar relations are avoided).
- Subjects who received any type of orthodontic treatment.
- Subjects with musculoskeletal disorders.
- Subjects on medication, affecting motor function.

The TMJ evaluation was conducted using the Philips just-vision, and the images were obtained with a high-resolution real-time 56-mm/12-MHz linear-array transducer.

Method of Examination

The patients with clicking sound were diagnosed by palpation as well as auscultation method. A detailed case history and consent were obtained from the patient.

A bilateral ultrasound scan of the TMJ was performed for each patient in the study group and control group. All subjects were examined in both TMJs (right and left) by the same radiologist.

Acoustic coupling agent was applied on the transducer; then, it was positioned against the skin surface of the TMJ in a transverse direction running parallel to the Camper line (the line intersecting the ala of the nose and the tragus of the ear).

Static imaging was used to evaluate the distance between the articular capsule (a hyperechoic line running parallel to the surface of the mandibular condyle) and the lateral surface of the mandibular condyle. When visible, a normally positioned disc could be identified as hypoechogenic structure surrounded by a hyperechogenic line, corresponding to the articular capsule. The distance is measured on the display of the ultrasound equipment twice, while the subject's jaws are at rest (Figs. 2 and 3).

In each scan, the operator measured the distance between the most lateral point of the articular capsule and the most lateral point of the mandibular condyle (lateral capsule–condyle distance).

Then, the distance between the most anterior point of the articular capsule and the most anterior point of the mandibular condyle (anterior capsule–condyle distance) was measured (Fig. 1).

Data collected were based on interview, clinical examination and through scan reports of the patient (Fig. 2 and 3).

Results

Table 1 shows the descriptive statistics of the control group data. The mean LCCD of all the 50 joints in the control group was 1.3630 mm and the mean ACCD of the 50 joints was 1.4850 mm. These values were compared with each of the 50 symptomatic joints scanned in the study group. It was noted that 56% of the subjects showed deviation towards right side and 44% showed deviation towards right side. Clicking sound on opening the mouth was observed on palpation in 28% of the subjects on the left side. In total, 16% had clicking on the right side and bilateral clicking was found in 56% of subjects on mouth opening (Fig. 4). On closing the mouth, 16% of the subjects had clicking on the left side and 4% on the right side and 8% had bilateral clicking. Clicking on closing the mouth was absent in 72% of the subjects (Fig. 5). Clicking was heard in all the subjects while opening the mouth on auscultation.

Fig. 1 Anterior capsule–condyle distance: distance between the most anterior point of the articular capsule and the most anterior point of the mandibular condyle

Fig. 2 Ultrasound scan showing echogenic structure surrounded by a hyperechogenic line

Clicking upon closing the mouth was heard on auscultation in 16% of the subjects in the left TMJ and on the right side in 8% of the subjects. Bilateral clicking was found in 8% of the subjects and was absent in 68% of the subjects (Fig. 6). The frequency and percentage distribution of negative and non-negative deviations of LCCD from that of control group were noted. In total, 40% showed negative deviation and 60% showed non-negative deviation (Fig. 7). In total, 24% of the subjects showed negative deviation and 76% showed non-negative 190 deviation of ACCD when compared with the control group (Fig. 8). *T* test shows that with respect to LCCD measurement, there is no significant difference between symptomatic and asymptomatic subjects. ACCD measurements are significantly different between the symptomatic and asymptomatic subjects (Table 2).

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Fig. 3 Illustration of the hypo- and hyperechogenic lines on ultrasound scans

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Table 1 The mean value obtained for LCCD and ACCD by measuring the asymptomatic individuals

	<i>N</i>	Range	Minimum	Maximum	Mean	SD
Age	50	17	22	39	29.60	3.949
LCCD (in mm)	50	1.3200	0.7600	2.0800	1.363000	0.2911010
ACCD (in mm)	50	1.0600	0.9400	2.0000	1.485000	0.2915353
Valid <i>N</i> (listwise)	50					

Bold indicates the final values

CLICKING SOUND ON PALPATION DURING OPENING THE MOUTH

Fig. 4 Side distribution of clicking sound heard on palpation while opening the mouth

CLICKING SOUND ON AUSCULTATION DURING CLOSING THE MOUTH

Fig. 6 Side distribution of clicking sound heard on auscultation while closing the mouth. For left side, it is 16%, right 8%, bilaterally 8%, and it is absent in 68% of the cases

CLICKING SOUND ON PALPATION DURING CLOSING THE MOUTH

Fig. 5 Side distribution of clicking sound heard on palpation while closing the mouth

LCCD -DEVIATIONS BY SYMPTOMATIC WITH ASYPTOMATIC

Fig. 7 The frequency and percentage distribution of negative and non-negative deviations of LCCD from that of control group

Fig. 8 The frequency and percentage distribution of negative and non-negative deviations of ACCD from that of control group

Discussion

Disc displacement is common in individuals who are asymptomatic. The prevalence of asymptomatic disc displacement on MR images has been reported to be 34% [10]. And because of this high prevalence of disc displacement found in asymptomatic TMJs, it has been suggested that the condition represents a congenital normal anatomic variant. Among all the diagnostic modalities sonography is an ideal method for this purpose, because it is non-invasive and less expensive to perform than are any other imaging techniques used to detect internal derangement of the TMJ.

The diagnostic value of USG to detect TMJ disorders began before the physiological USG anatomy was identified. According to Manfredini et al. [8], only two papers addressed this aspect as the primary aim of investigation, and few others focused on condylar range of motion in asymptomatic subjects. This represents a strong limitation to current research on this topic, since the absence of clear and validated parameters of normality prevented ultrasound assessments in pathological joints being compared with a known standard of reference for normality. In the present study, to avoid this bias a control group was taken, who were clinically examined and ruled out for any joint problems.

Studies done by Lands et al. [9] have stressed the impossibility of visualizing the articular disc in all cases, and image interpretation is not standardized because the definition and echogenic properties of the disc are not the

same in different studies. These considerations have led some people to search for indirect USG signs of disc displacement. Hayashi et al. [10] proposed an indirect sign to evaluate the anterolateral position of the disc, which was the distance between the articular capsule and the lateral surface of the condyle. Similarly, the concept of LCCD and ACCD was given by Pereiara [11]. These guidelines were followed in the present study. Emshoff et al. [12] revealed a high correlation between the prospective high-resolution USG diagnosis of disc displacement and the findings at MRI, with a positive prediction of 97% for disc displacement at the closed-mouth position, and variations in the measurements of this distance are more likely to occur with transverse scanning [13].

There is confusion in the literature regarding the resolution of the transducer used for determining the disc. A high-resolution transducer of 12 MHz is used in the current study for better visualizing the TMJ structures which is similar to that used in the study done by Jank et al. The disc appeared hypoechoic which is a similar finding of Landes et al. [14] and Jank et al. [15] in their studies, who used 10- and 12-MHz transducers, respectively. In order to increase the accuracy of this study, individuals were included only if they were diagnosed with clicking sound on palpation and/or auscultation and those with bruxism [16, 17].

In the control group, the mean ACCD did not show marked variation, among the males and females, whereas the mean LCCD showed variation. This proves that the ACCD is a more accurate measurement in establishing an ultrasound diagnosis, similar to the study done by Çakır-Özkan et al. [18]. All the 50 symptomatic joints in the study group showed variation in LCCD as well as ACCD when compared to the mean obtained from the control group. This clearly indicates that there is increase/decrease of these parameters in case of individuals with disc displacement, supporting the literature.

But on statistical analysis only ACCD was found to be significant. Hence, ACCD is a better parameter than that of LCCD to come to an USG diagnosis. The findings agree with the literature, and their results support the hypothesis, also suggested by others, that anterior capsule–condyle distance is more specific for disc displacement assessment.

However, there are certain drawbacks in the study such as all the readings were taken by a single radiologist. Since ultrasonography is done in static and dynamic positions, it is presumed that the landmarks will not vary drastically

Table 2 Deviation of LCCD and ACCD of sympatamatic individuals from the asymptomatic mean obtained

	N	Mean	SD	Mean difference	Sig.	P value	Conclusion
Deviation from asymptomatic mean LCCD	50	0.107	0.463	0.107	0.108	> 0.05	Not sig.
Deviation from asymptomatic mean ACCD	50	0.251	0.336	0.251	0.000	< 0.05	Highly sig.

when done on the similar machine by a different operator. The other drawback is that only the displacement of the disc confirmed and the integrity of the disc in more complex TMDs cannot be accessed. Hence, this study is only confined to see the role of ultrasound in accessing the low-grade TMDs in comparison with other diagnostic imaging.

It was possible to identify the temporomandibular joint (condyle, glenoid fossa, disc) using ultrasonography in the current study. Joints which appeared normal on palpation were found to be abnormal on auscultation. As TMJ is a double joint, for all the patients with unilateral complaint, the contralateral joint was also affected invariably. The mean LCCD and ACCD of asymptomatic individuals are **1.363** and **1.485 mm**, respectively.

All the joints in the study group (subjects clinically diagnosed with internal derangement) presented with clear variation from the mean obtained from the control group, supporting the clinical diagnosis of internal derangement with reduction. Similar to the other studies conducted on TMJ, in the current study also ACCD was identified as a significant measurement than LCCD.

Conclusion

Hence, it can be concluded that auscultation is mandatory in the examination of the temporomandibular joint for clicking sound. Ultrasonography, which has shown high specificity, can supplement clinical evaluation in patients with TMJ disorders and can be used as a potential diagnostic tool for identifying internal derangement of the temporomandibular joint with reduction. However, it cannot identify complex TMDs where the integrity of the disc itself is questionable. Ultrasonography is a non-invasive and inexpensive diagnostic procedure, and the preliminary diagnostic information offered by it can throw light on the clinical condition of the joint, which enables the clinician to decide the treatment plan, before subjecting the patient to any higher risk radiographic exposures and/or surgical procedures.

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Compliance with Ethical Standards

Conflict of interest None of the authors have any conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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