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Ultrasonography of the temporomandibular joint: a literature review

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Abstract. This review summarizes knowledge on the accuracy and clinical usefulness of ultrasonography (US) for the diagnosis of temporomandibular joint (TMJ) disorders. A systematic search in the National Library of Medicine's Database was performed to identify all peer-reviewed papers in the English literature that assessed the accuracy of US with respect to magnetic resonance (MR), computerized tomography (CT), clinical assessment or autopsy specimens for the diagnosis of TMJ disk displacement, effusion and osteoarthrosis. The combined search words ''ultrasonography'' and ''temporomandibular joint'', ''temporomandibular disorders'', ''effusion'', ''disk displacement'', ''condyle'', yielded 20 papers. Most studies (N = 17) focused on detecting disk displacement, with less emphasis on assessing joint effusion (N = 6) and osteoarthrosis (N = 7). US accuracy was 54–100% for diagnosing disk displacement, 72–95% for joint effusion and 56–93% for osteoarthrosis. US is operator-dependent. Better standardization of the technique is required and normal parameters must be set. Standardization is also required for the taxonomic aspects of pathologies. Despite these limitations, US remains potentially useful as an alternative imaging technique for monitoring TMJ disorders, particularly the presence of intrarticular effusion.

Keywords: temporomandibular joint; ultrasonography; temporomandibular disorders; disk displacement; effusion; osteoarthrosis; TMJ; TMD.

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Magnetic resonance (MR) is the reference standard for imaging techniques for the visualization of the temporomandibular joint (TMJ)[53,58], allowing the depiction of inflammatory changes within the joint space[49,57] and positional abnormalities of the joint disk[2,6]. MR cannot be carried out in some patients (those with pacemakers, claustrophobics) and its use is limited by its cost and the time it takes. The need has arisen for alternative radiological techniques that have good diagnostic accuracy and reliability and are inexpensive, quick and not invasive.

Some authors have considered ultrasonography (US), which is used to study other diarthroidal joints, such as the shoulder and knee[22]. US has potential advantages over MR, and some supported its accuracy in depicting effusion in larger joints[29,44]. The use of US for studying the TMJ is not common clinical practice, even though there have been encouraging findings in diagnostic agreement with MR for joint effusion and disk displacement[9].

The absence of systematic reviews of the literature on this subject represents a deficiency in knowledge. The purpose of this review is to determine whether the evidence available is sufficient to demonstrate the accuracy of US to diagnose TMJ disorders.

Background

Researchers in the field of TMJ disorders have been trying to find a method of gaining better images of the joint, to correlate clinical findings with objective signs. In the 1990 s, in an attempt to find an alternative technique to MR, US was applied to the study of the TMJ[46,51]. Despite some preliminary encouraging reports, US was not widely taken up. The main papers about the technique were published by a few authors. The introduction of high resolution transducers allowed improved diagnostic accuracy, but standardization of the investigation method has not been achieved.

Technique

US uses a transducer that functions as a transmitter and a receiver of acoustic energy. Ultrasounds emitted by the transducer are partly reflected when they pass through the tissues, with a coefficient of reflection that depends on the characteristics of different anatomical structures (e.g. cortical bone has the highest echogenity, which reflects most of the ultrasound waves; soft tissues have a lower echogenity). The same transducer receives the reflected ultrasounds, translating them into images[22].

The TMJ area, which includes bone (condylar and temporal bone), connective (joint caspule and rertrodiscal tissues), fibrocartilagineous (disk), and muscular (lateral pterygoid and masseter muscles) tissues, has some peculiarities with respect to other musculoskeletal areas. The small examination area, with limited accessibility to the deep structures, and the high risk of ultrasound reflecting off bone tissues make the interpretation of images complex.

The imaging protocol includes transverse and longitudinal scans so the antero-superior joint compartment can be examined in coronal, axial and oblique views. A linear probe, with a frequency of 7.5–20 MHz is placed over the TMJ, perpendicular to the zygomatic arch and parallel to the mandibular ramus and tilted until the best view is achieved. When a satisfactory view is obtained, static and dynamic evaluations are usually performed at different mouth opening positions.

Cortical bone tissues, such as the head of the condyle and the glenoid fossa, are generally hyperechoic (high reflection of sound waves) (Figs. 1 and 2); appearing white on US images, while bone marrow is usually hypoechoic (low reflection of sound waves) and appears black. Connective (joint capsule and retrodiscal area) and muscular tissues (lateral pterygoid and masseter muscles) are isoechoic (intermediate reflection of sound waves) and appear heterogeneously grey in US images. Empty spaces and water (superior and inferior joint spaces) are hypoechoic (black), even though they are virtual cavities that are usually not detectable, unless effusion is present. The articular disk consists of dense fibrocartilagineous tissue, and usually appears as a thin area of hyperechogenity surrounded by a hypoechoic halo, even though its depiction with US is controversial (Fig. 3).

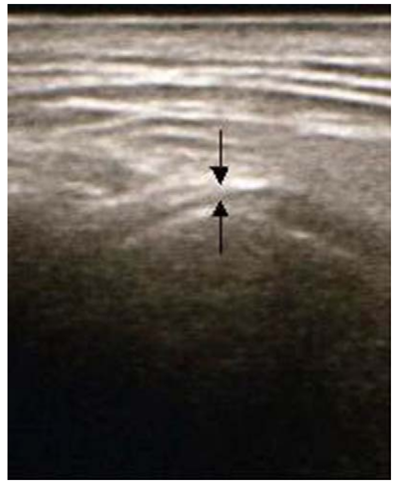

Fig. 1. US of the TMJ. Hyperechoic lines (white) represent the glenoid fossa (superior line) and condylar surface (inferior line), respectively. The distance between the two lines is an indirect measure of joint effusion due to capsular distension. Surface irregularities may suggest the presence of bone remodelling.

Fig. 2. US image of an oversized TMJ condyle.

Fig. 3. The articular disk (black arrow) is visualized between the two joint bone surfaces. The possibility of seeing it in every mouth opening position is controversial.

Materials and methods

A systematic search in the National Library of Medicine Database was carried out to identify all peer-reviewed papers in the English literature dealing with the application of US to the TMJ. The search term ''ultrasonography'', yielded 234933 citations. It was combined with the terms ''temporomandibular joint'', ''temporomandibular disorders'', ''temporomandibular joint effusion'', ''temporomandibular joint disk displacement'', and ''temporomandibular joint condyle'' in this study (Table 1).

All studies assessing the diagnostic accuracy of US (by comparing US findings with MR, computerized tomography (CT) and/or clinical assessment) for the evaluation of TMJ disk position, joint effusion, and osteoarthrosis were included in this review. Non-systematic reviews, case reports and descriptive studies were excluded.

Titles and abstracts obtained from the search were screened according to these inclusion criteria and all studies that appeared to meet the criteria were retrieved as complete articles. Abstracts providing unclear data were also retrieved as full text articles to avoid excluding papers of possible relevance.

Results

The search strategy provided 97 abstracts, including 8 reviews, for the combined search terms ''ultrasonography and temporomandibular joint''. Screening of the abstracts showed that 38 papers were potentially relevant to this review.

The search terms ''ultrasonography and temporomandibular disorders'' yielded 72 citations, all of which had been identified using the terms ''ultrasonography and temporomandibular joint''. Citations identified by combining ''ultrasonography'' with the ''temporomandibular joint condyle'', ''temporomandibular joint disk displacement'', and ''temporomandibular joint effusion'', yielded 33, 14, and 6 citations,

Table 1. Medline search strategy.

Search Word(S)	Citations	Reviews
Ultrasonography	234933	22668
Ultrasonography and Temporomandibular Joint	97	8
Ultrasonography and Temporomandibular Disorders	72	5
Ultrasonography and Condyle	33	0
Ultrasonography and Disk Displacement	14	0
Ultrasonography and Temporomandibular Joint Effusion	6	0

Table 2. Main study: parameters of selected clinical studies.

Outcome Variable(s)	No. of studies
Disk Displacement	10
Disk Displacement/Condylar Abnormalities	3
Disk Displacement/Condylar Abnormalities/Joint Effusion	3
Joint Effusion	2
Disk Displacement/Joint Effusion	1
Condylar Abnormalities	1

respectively, all of which were subgroups of the larger group. No other relevant citations were retrieved using these combined search terms.The search was also extended to the related articles in the Medline Plus database, but no other papers satisfying the inclusion criteria were identified. No other relevant papers were identified in a search of the indexes of the library collection of the University of Padova.

38 papers were obtained as full reports potentially to be included in the review. Seven (N = 7) of these papers were non-systematic reviews, clinical notes or descriptive studies[1,9,28,45–47,50], three (N = 3) were case reports on TMJ surgery in which US was used pre- or post-surgically to identify soft tissues lesions[27,34,35]; both types of studies were excluded from the review. Two studies (N = 2)[11,51] attempted to describe parameters of normality, and were excluded from the review due to the impossibility of drawing information about US accuracy. Six other studies (N = 6)[5,19,30,33,40,41] described the potential assessment of condylar range of motion using US, and were excluded from the review owing to their lack of information about the accuracy of US to define such a parameter. The remaining 20 (N = 20) papers were clinical studies assessing the accuracy of US in the evaluation of disk displacement (N = 10)[4,12,15–17,21,24,32,54,56], disk displacement and osteoarthrosis (N = 3)[13,31,48], disk displacement, joint effusion and osteoarthrosis (N = 3)[23,36,43], joint effusion (N = 2)[38,55], disk displacement and joint effusion (N = 1)[37], osteoarthrosis (N = 1)[3] (Table 2). All 20 papers were suitable for inclusion in the review.

Discussion

Disk position and morphology

Most data about TMJ US came from studies assessing TMJ disk position (Table 3). In most studies, the diagnostic accuracy of US was measured by taking MR findings as the standard of reference[4,12,13,15-17,23,24,31,32,36,43,54,56], but US findings have also been compared with autopsy specimens[48], CT[21], and clinical assessment[37]. Descriptive studies of disk position and morphology in the normal joints of asymptomatic volunteers have been conducted[11,51].

In general, results from these reports are encouraging, although findings are

Table 3. Summary of studies assessing the TMJ disk position.

Authors	Sample Size (joints)	Comparison Exam	SE (%)	SP (%)	PPV (%)	NPV (%)	ACC (%)
Landes et al., 2006[32]	106	MR	53 CM 62 OM 43	74 CM 62 OM 85	49 CM 57 OM 41	77 CM 67 OM 86	70 CM 62 OM 77
Landes et al., 2006[31]	136	MR	64	73	42	87	71
Rudisch et al., 2006[48]	60	AS	73	75	89	50	73
Manfredini et al., 2005[36]	136	MR	56.7	73.7	63	68.3	66.2
Tognini et al., 2005[54]	82	MR	65.8	80.4	77.1	70.2	73.1
Jank et al., 2005[23]	200	MR	CM 92 OM 86	CM 92 OM 91	CM 96 OM 86	CM 84 OM 92	CM 92 OM 90
Emshoff et al., 2003[13]	96	MR	N.A.	N.A.	N.A.	N.A.	80-93 (DDNR)
Brandlmaier et al., 2003[4]	96	MR	DDR 58 DDNR 75	DDR 92 DDNR 84	DDR 83 DDNR 71	DDR 81 DDNR 87	DDR 83 DDNR 71
Manfredini et al., 2003[37]	94	C	N.A.	N.A.	N.A.	N.A.	81.9
Melchiorre et al., 2003[43]	66	MR	69.6	30.3	69.6	30.3	57.6
Uysal et al., 2002[56]	64	MR	100	100	100	100	100
Emshoff et al., 2002[15]	128	MR	DDR 82 DDNR 83	DDR 95 DDNR 96	DDR 82 DDNR 94	DDR 95 DDNR 87	DDR 90 DDNR 92
Emshoff et al., 2002[16]	58	MR	N.A.	N.A.	CM 97 OM 88	CM 81 OM 97	CM 91 OM 93
Emshoff et al., 2002[17]	416	MR	CM 80 OM 68	CM 87 OM 93	N.A.	N.A.	CM 82 OM 82
Jank et al., 2001[24]	132	MR	CM 78 OM 61	CM 78 OM 88	CM 87 OM 79	CM 65 OM 77	CM 78 OM 77
Hayashi et al., 2001[21]	36	CT	83	96	N.A.	N.A.	92
Emshoff et al, 1997[12]	34	MR	S 41 D 31	S 70 D 95	S 61 D 88	S 51 D 55	S 54 D 60

SE = sensitivity; SP = specificity; PPV = positive predictive value; NPV = negative predictive value; ACC = accuracy; MR = magnetic resonance; AS = autopsy specimens; C = clinical assessment; CT = computerized tomography; CM = closed mouth; OM = open mouth; DDR = disk displacement with reduction; DDNR = disk displacement without reduction; S = static ultrasonography; D = dynamic ultrasonography.

variable. Diagnostic accuracy of US to detect disk displacement ranged from 62% to 100%, and reported sensitivity (31–100%), specificity (30–100%), positive (41–100%) and negative (51–100%) predictive values are even more variable in different papers. This variability is only partly explained by the introduction of high-resolution US (12 MHz or more), which allows better visualization of joint structures compared with the low-resolution instruments used in the first reports, and is likely to affect the standardization of US assessment and imaging interpretation.

A recent report by Jank et al.[23] reported accuracy of 92% and 90% with closed and open mouth positions, respectively, with a sensitivity of 86–92% and a specificity of 91–92%. These findings represent a marked improvement compared with the first report from the same group of researchers, in which a low-resolution instrument was used to perform static and dynamic scans, with a reported sensitivity of 31–41% and specificity of 70–95%[12].

Even considering the most recent studies, the literature findings are contradictory. In a study by Uysal et al.[56], US showed perfect agreement with MR, correctly identifying all cases of normal disk–condyle relationship (N = 9), disk displacement with reduction (N = 11), and disk displacement without reduction (N = 12).

These findings are not in agreement with those reported by Manfredini et al.[36] and Tognini et al.[54], who described a high number of false-negative results and some false-positives. Sensitivity and specificity in those studies were 57–66% and 74–80%, respectively, and are in accord with other work suggesting that US seems to be more specific than sensitive for the detection of TMJ disk displacement.

Specificity was higher than sensitivity in most papers[4,12,17,21,31,32], Jank et al. found similar values[23,24], and only Melchiorre et al.[43] reported higher sensivity values. The latter are probably explained by the unclear diagnostic specifications provided by the authors, who generically assessed the presence of alterations of the TMJ disk and adopted an unclear scan protocol for image interpretation[42].

Although most papers agree that US has better specificity than sensitivity, there are some unexplained differences between papers conducted by the same group of researchers, as in the case of the three groups of authors having more than one publication (i.e. the groups of Emshoff, Rudisch, Jank, Brandlmaier et al.; Manfredini, Tognini et al.; Landes et al.). This suggests that progress has yet to be made in standardizing US assessment of the TMJ.

The diagnostic value of US to detect TMJ disorders began before the physiological US anatomy was identified. To the authors' knowledge, only two papers addressed this aspect as the primary aim of investigation[11,51], and few others focused on condylar range of motion in asymptomatic subjects[5,19,30,33,40,41]. This represents a strong limitation to current research on this topic, since the absence of clear and validated parameters of normality prevented US assessments in pathological joints being compared with a known standard of reference for normality.

Some literature findings are hard to explain if the TMJ joint anatomy and physiopathology are considered, which makes the possibility of discriminating between disk displacement with and without reduction questionable. Most cases of displacement are in an antero-medial direction, indicating that when, during the opening movement, the condyle slides along the articular eminence, moving forward, downward and medially to locate under the articular apex, the disk is placed between these two osseous structures[7,8,18].

One of the major shortcomings of US is represented by the deviation and abnormal reflection of ultrasounds when they intercept hard tissues, therefore it appears impossible to recognize the disk when it is placed between two hard structures and far from the ultrasound source.

Tognini et al.[54] suggested that the appropriate moment to establish whether a displaced disk regains a correct relationship with the condyle is the initial phase of the opening movement and the corresponding terminal phase of the closing movement. According to these suggestions, disk displacement with reduction in the final phase of opening is hardly distinguishable from displacement without reduction. For these reasons, in their study US diagnosis of anterior disk position was compared with MR findings without taking into account the presence/absence of reduction due to the impossibility of achieving satisfactory imaging of the articular disk in the open-mouth position in some cases.

These observations contrast with findings from Jank et al.[24], who reported high US specificity and a fair sensitivity for evaluating the disk–condyle relationship in the open-mouth position, and those of Brandlmaier et al.[4], who showed good agreement with MR findings of disk displacement without reduction.

Other studies have stressed the impossibility of visualizing the articular disk in all cases[11,32], and image interpretation is not standardized because the definition and echogeneic properties of the disk are not the same in different studies. These considerations have led some authors to search for indirect US signs of disk displacement. Hayashi et al.[21] proposed adopting the lateral capsule–condyle distance as a landmark of disk displacement, suggesting that this distance is probably enlarged in cases of displacement. Such a method, despite revealing good agreement with CT, is questionable anatomically because a displaced disk should enlarge the lateral joint capsule only if displacement occurs in the antero-lateral direction or associated effusion is present. Even though anteriorly displaced disks may frequently be directed laterally[7,8], sideways disk displacements in a lateral direction, which would be required to enlarge the lateral capsular thickness, are less frequent than medial ones[18]. The association between effusion and disk displacement is debated[14,52]; indirect diagnosis of disk displacement has to be evaluated further.

Aspects requiring further study include the standardization of the examination, interobserver calibration, adopting a common taxonomic definition for pathology. The standardization of a US protocol for the TMJ is difficult. Most studies have adopted an imaging protocol including transverse and longitudinal scans to evaluate the antero-superior joint compartment in coronal, axial and oblique plans. The probe is placed over the TMJ perpendicular to the zygomatic arch and parallel to the mandibular ramus and is tilted until the best view is achieved, then static and dynamic evaluations are performed. The need to tilt the probe to gain the best view into the joint and the absence of validated anatomical parameters of normality, which should help to improve the repeatability of the examination, make US an operator-dependent technique.

Efforts have been made by Emshoff, Jank, Rudisch et al. to gather data on these aspects. Good intra-observer reliability was reported[17], and a protocol, including a retrospective US assessment after determining the MR findings, was proposed to describe and analyze errors in the interpretation of US[24].

An autopsy study showed that the accuracy of US for the diagnosis of disk displacement is 73% and that an optimal view of the articular disk may be obtained with scans of 60° or less off the perpendicular in relation to the long axis of the disk[48]. The same study showed that the articular disk is usually hypo- to isoechoic, and that echogeneity increases with disk degeneration. Artifacts in disk echogeneity may be present if the orientation of the

Table 4. Summary of studies assessing the presence of joint effusion.

Authors	Sample Size (joints)	Comparison Exam	SE (%)	SP (%)	PPV (%)	NPV (%)	ACC (%)
Manfredini et al., 2005[36]	136	MR	85.1	66.7	85.1	66.7	79.4
Jank et al., 2005[23]	200	MR	81	100	100	93	95
Manfredini et al., 2003[37]	94	C	N.A.	N.A.	N.A.	N.A.	80
Melchiorre et al., 2003[43]	66	MR	70.6	75	75	70.6	72.2
Tognini et al., 2003[55]	88	MR	75.6	76.5	73.8	78.2	76.1
Manfredini et al., 2003[38]	138	MR	N.A.	N.A.	N.A.	N.A.	81.7

SE = sensitivity; SP = specificity; PPV = positive predictive value; NPV = negative predictive value; ACC = accuracy; MR = magnetic resonance; C = clinical assessment.

sonographic beam is not exactly the same as the disk surface[48].

These observations may explain the different parameters for disk echogeneity adopted in the literature, and suggest a possible parameter of normality for disk echogeneity and provide useful information for US assessment standardization.

Another point of concern when analyzing data from the literature is the differences in terminology to describe the same clinical conditions. Disk displacement, internal derangement, anterior disk position are all terms indicating an anteriorized sonographic position of the articular disk with respect to the condyle. Future studies should strictly adhere to the current TMJ disorders literature, which has abandoned the term internal derangement and adopted disk displacement[10]. The proposal to use the term anterior disk position[35], which has no pathologic implications, has to be discussed, because it derives its biological plausibility from MR investigations showing an anterior disk position in many asymptomatic subjects[26].

Joint effusion

US has been widely employed to detect effusion in many musculoskeletal areas; it is accurate at depicting the presence of intrarticular inflammatory fluids in larger joints[9,22,25,29,44].

TMJ effusion, as depicted with imaging techniques, is likely to be related to clinical pain on palpation, which appears to be related to images of joint effusion[20,39] and not disk position abnormalities[2]. Pain is the main reason for patients to seek treatments for TMJ disorders, so it appears contradictory that most TMJ investigations have focused on the assessment of the disk–condyle relationship and only six papers evaluate the accuracy of US to detect joint effusion[23,36–38,43,55] (Table 4).

There is consensus that the presence of joint effusion may be detected by direct visualization of a hypoechoic area within the articular space or by an indirect measurement of capsular distension, taken as the distance between condylar latero-superior surface and the articular capsule (a hyperechoic line running parallel to the surface of the mandibular condyle) with the subject in the closed-mouth position (Fig. 4).

A preliminary study by Manfredini et al.[37] reported good agreement (80%) between a US diagnosis of joint effusion and clinical pain on joint palpation. The same authors, in a series of papers, have tried to standardize parameters for a US diagnosis of TMJ effusion by a comparison with MR findings. Manfredini et al.[38] have tried to establish cut-off values for the latter parameter by using US measures of capsular width (mm) and MR diagnosis of TMJ effusion (presence/absence) to perform a receiver operating characteristic (ROC) curve analysis. Diagnostic accuracy of US to detect MR-depicted TMJ effusion was good, and the ROC curve analysis suggested that the critical area is that around the 2 mm TMJ capsular width value (lower values had high sensitivity; higher values had high specificity).

A subsequent paper taking the 2 mm (or more) capsular width as the threshold to discriminate between the presence/absence of effusion found an 85% sensitivity and a 67% specificity in a patients with TMJ disorders and rheumatism[36]. These values are lower than those reported by Jank et al.[23], who described a sensitivity of 81%, a specificity of 100% and an accuracy of 95% in a sample of 100 patients with TMJ disorders.

Fig. 4. The presence of joint effusion can be detected indirectly by measuring the distance between the two articular surfaces (clips).

Findings from papers assessing the accuracy of US to diagnose TMJ effusion are encouraging and warrant further evaluation. Standardization of the parameters adopted to detect joint effusion (i.e distance between condylar latero-superior surface and the articular capsule) appears to be easier to achieve with respect to disk position evaluation, even though studies assessing intra- and inter-operator reliability are lacking.

It is accepted in other fields of medicine that US provides only limited information about subchondral bone, menisci and cartilage, while it is increasingly used to detect synovitis and effusion in several joints[25,29,44]. In accordance with data provided from studies on other joints (knee, shoulder, hip), findings from the studies by Manfredini et al.[36–38], showed higher sensitivity than specificity, indicating the capability to detect pathological joints, which is an important quality for an instrument that can be used to monitor treatment efficacy.

These considerations become more important if one considers that the clinical significance of disk position abnormalities has been questioned in recent years[26,52], and that inflammatory changes within the TMJ have been described as the possible first localization of many systemic conditions[9,25]. Considering the small amount of literature on this issue, it is recommended that future investigations should address the topic of US diagnosis of TMJ effusion.

Osteoarthrosis/Condylar abnormalities

Data from many medical fields suggest that US assessment of hard tissue pathologies is less accurate than that for soft tissues[9,22]. There are some preliminary studies on the evaluation of osteophytes, bone abnormalities and joint space narrowing in large joints[25]. Data on the TMJ came from studies assessing the presence of abnormalities within the condylar surface, which are often referred to as osteoarthrosis[3,31] (Table 5).

Table 5. Summary of studies assessing the presence of condylar abnormalities.

Authors	Sample Size (joints)	Comparison Exam	SE (%)	SP (%)	PPV (%)	NPV (%)	ACC (%)
Landes et al., 2006[31]	136	MR	70	76	44	90	75
Rudisch et al., 2006[48]	60	AS	95	90	95	90	93
Manfredini et al., 2005[36]	136	MR	67.3	26.3	70.2	23.8	55.9
Jank et al., 2005[23]	200	MR	94	100	100	45	94
Melchiorre et al., 2003[43]	66	MR	N.A.	N.A.	N.A.	N.A.	N.A.
Brandlmaier et al., 2003[3]	80	MR	87	20	88	18	79
Emshoff et al., 2003[13]	96	MR	83	63	34	94	67

SE = sensitivity; SP = specificity; PPV = positive preictive value; NPV = negative predictive value; ACC = accuracy; MR = magnetic resonance; AS = autopsy specimens.

US diagnosis of erosions is commonly based on the detection of an interruption or absence of the echogeneity of the cortical lining. Owing to the deflection of sound waves by bone structures, the medial aspect of the condyle can hardly be depicted, and osteophyte formation and condylar erosion are more easily seen in the anterior or lateral aspect of the condyle. Condylar morphology is best seen on longitudinal scans, but transverse investigation may help to increase the examiner's confidence that the condyle has osteoarthrosis[3,48].

A recent autopsy study by Rudisch et al.[48] showed that condylar erosion was sonographically detected with a sensitivity of 95%, specificity of 90%, and accuracy of 93%. The positive and negative predictive values were 95% and 90%, respectively. These findings were markedly better than those reported by the same group in a previous MR study that, along with an accuracy of 79% and a positive predictive value of 88%, showed an unacceptable negative predictive value (18%)[3]. Manfredini et al.[36], although reporting lower absolute values, due to the use of a lower resolution probe, showed that the negative predictive value of US assessment of condylar abnormalities was low (24%).

In contrast, a 3D US study by Landes et al.[31] reported a good negative (90%) and a low positive predictive value (44%), indicating that the diagnosis of osteoarthrosis is not reliable. In general, the studies described above support the conviction that hard tissues pathologies cannot be diagnosed with an acceptable predictability and the use of US is not indicated. These suggestions are not in agreement with claims that US, despite its limitations, is an ideal method for evaluating the condyle and its abnormalities[3,48], although this is supported by only one of seven studies addressing this topic.

Brandlmaier et al.[3] noted that it is possible that many of the osteoarthrotic changes diagnosed with US were not visible with MR images, which may represent an imperfect standard of reference. The autopsy data reported by Rudisch et al.[48] may constitute a representative insight to the potentiality of US to assess osteoarthrotic changes within the TMJ.

Conclusive remarks

In conclusion, US is an imaging technique that has been applied in several medical fields owing to its potential advantages over MR in terms of non-invasivity and lower cost. US has been applied to the study of many diarthroidal joints, and it has been suggested that it can provide useful information for the assessment of TMJ disorders.

A critical analysis of the literature on TMJ US draws the following conclusions. Three major fields of interest can be defined for US of the TMJ: assessment of disk position abnormalities, joint effusion, and bone pathologies. Most literature focuses on the detection of disk displacement. The data are generally positive for all the pathologies studied, but further research is required before the results can be generalized. US is dependent on the operator's skill and training. Even though most data came from the same few groups of researchers, the variability of the results emphasizes the need for better standardization of the technique. Progress in this direction might be achieved with basic research on the ultrasonographic physiology of the TMJ, which may help to determine the normal parameters. Standardization of the taxonomic aspects of pathologies is also required. Clinical concepts that put the clinical significance of disk position abnormalities into question have to be taken into account in future research. Despite these limitations, US remains potentially useful in the clinical setting as an alternative imaging technique to monitor patients with TMJ disorders, particularly the presence of intrarticular effusion, which seems to be the easiest parameter to standardize.

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None declared.

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