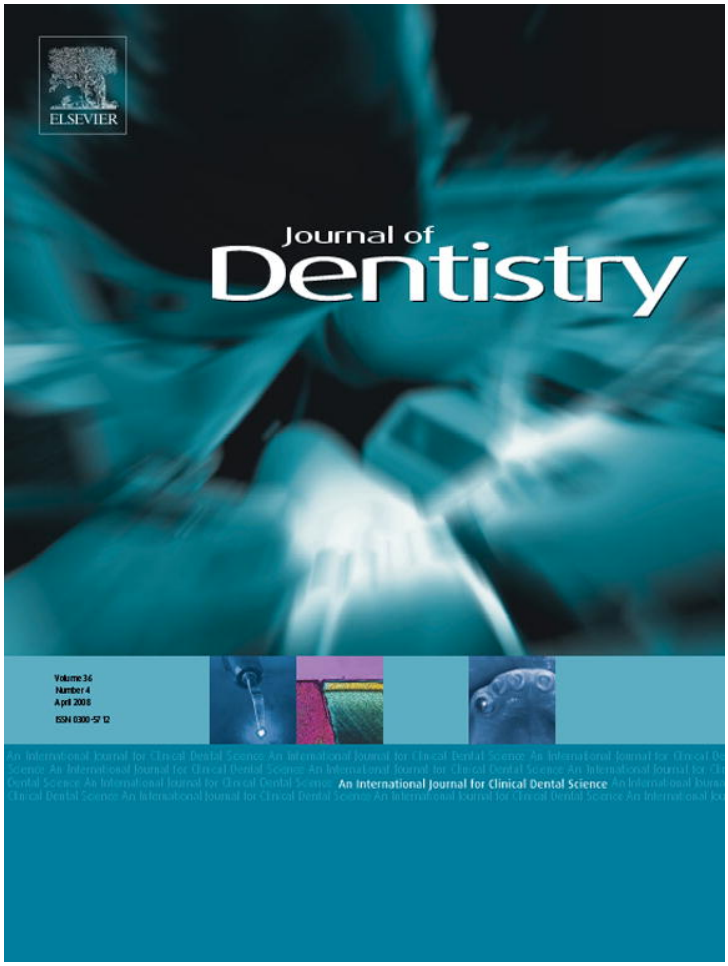

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# Temporomandibular joint click sound and magnetic resonance-depicted disk position: Which relationship?

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ABSTRACT

*Aims:* The aim of this work was to evaluate the agreement between temporomandibular joint click sound and MR diagnoses of different disk positions.
*Methods:* One hundred ninety-four (N = 194) patients seeking treatment for temporomandibular disorders at the TMD Clinic, Department of Maxillofacial Surgery, University of Padova, Italy, underwent a bilateral magnetic resonance of the temporomandibular joints. The presence of click sounds was clinically assessed according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) and put into relation with different magnetic resonance (MR) diagnoses of disk–condyle position by means of permutation tests.
*Results:* The proportion of joints with reducing and non-reducing disk displacement which provided a click sound during the clinical assessment was similar (45.6% vs. 48.9%, respectively), while the prevalence of the two MR diagnoses in joints with click sound were strongly different (25.3% vs. 40.1%, respectively. Thus, the MR diagnosis which appears to be more positively associated with click sounds is disk displacement without reduction.
*Conclusion:* There is a weak form of dependence between click and MR diagnosis, and the MR diagnosis of DDNR seems to be more positively associated with the presence of click sounds than the other categories, which did not show significant positive associations with click (i.e. there is negative association between click presence and normal disk position and no association between click presence and DDR joints.



## 1. Introduction

Temporomandibular joint (TMJ) click sound is commonly recognized as a sign of internal derangement, and its recording is requested to make diagnosis of disk displacement with reduction according to the most widely adopted classification and diagnostic systems, both in the clinical and in the research settings.[1–5]

Nonetheless, the clinical significance of TMJ click sound as a pathological sign has been recently questioned in consideration of its weak association with pain and jaw function limitation,[6] that are the main reasons for temporomandibular disorders (TMD) patients to seek treatment.

More importantly, magnetic resonance studies showed that about one-third of asymptomatic and clinically healthy subjects has TMJ disk position abnormalities that would never be clinically typified as diseased.[7–9]

These considerations suggested the need for a re-evaluation of the usefulness of click sound, and TMJ sounds in general, as parameters of diagnostic validity. To do this, a description of the association between click and the anatomical relationship of the joint components may be of basic

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importance. It appears logical that similar investigations should be based on magnetic resonance (MR) findings, since such technique is currently considered the standard of reference for non-invasive diagnosis of TMJ disk displacement,[10] showing an accuracy of about 90–95% for detecting disk position abnormalities when both coronal and sagittal images are evaluated with respect to autoptic and surgical specimens.[11]

Considering these premises, this study, which is part of an ongoing investigation of the predictive value of clinical assessment, is an attempt to evaluate the agreement between temporomandibular joint click sound and MR diagnoses of different disk positions.

## 2. Materials and methods

### 2.1. Study sample and design

Participants were recruited among patients attending at the TMD Clinic, Department of Maxillofacial Surgery, University of Padova, Italy from September 2005 to May 2007 and seeking treatment for temporomandibular disorders. All subjects who underwent a bilateral magnetic resonance of the temporomandibular joints during the diagnostic process ($N = 240$) were asked to give their consent to use their MR findings from scientific purposes and all of them accepted. MR from 46 patients were excluded from statistical analysis due to the presence of systemic diseases affecting joint and/or masticatory muscles, such as fibromyalgia or other rheumatic diseases diagnosed according to the American College of Rheumatology criteria.[12]

Therefore, a total of 194 patients (153 females, 47 males; mean age 55.3; range 18–72) were included in the statistical analysis for an evaluation of the association between the different MR-diagnosed TMJ disk positions and the presence of click sound.

The study was carried out in a single-blind fashion, so each subject received a clinical assessment and underwent MR with the clinicians and the radiologist not knowing the result of the other investigation. The two examinations were conducted within 1 month from each other, and the patients underwent no treatment during this period.

All clinical assessments were performed by the same two trained investigators (D.M., L.G.N.), who had been previously calibrated until their reliability to record the study's parameters was in accordance with that reported in literature.[13,14] MR were interpreted by the same radiologist with expertise in temporomandibular joint, who made diagnosis of disk displacement according to parameters selected from literature.[7,14–16]

### 2.2. Clinical assessment

Clinical assessment was conducted according to a standardized clinical protocol, which includes evaluation of patients' history, palpation of TMJs, auscultation of joint noises and measurement of mandibular range of motion. According to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD),[5] a click sound was defined as a distinct sound, of brief and very limited duration, with a clear beginning and end, which usually sounds like a "click".

The presence of click sounds was detected by temporomandibular joint bilateral palpation, performed positioning the left index finger on the right TMJ and the right index finger on the left TMJ in the preauricular area, anterior to the ear tragus. The patient was asked to slowly open the mouth and the close to maximum intercuspation. The parameter "presence of click sound" was endorsed positively when a reciprocal click sound (click on both vertical opening and closing that occurs at a point at least 5 mm greater interincisal distance on opening than on closing and is eliminated on protrusive opening) and/or a click sound on both vertical range of motion (either opening or closing), reproducible on two of three consecutive trials, and click during lateral excursion or protrusion were identified by this technique in two of three consecutive trials.

### 2.3. Magnetic resonance

MR was carried out with a 1.5 T (GE Signa Contour; GE Medical Systems, Buc, France) with a bilateral dedicated circular (8 cm diameter) surface coil for the contemporary right and left TMJs study. The investigation protocol provided for a first axial scan "scout" from which seven sagittal-oblique slices in lateral-medial direction and coronals sections deviated obliquely in posteroanterior direction have been established. Gradient Echo sequences have been performed with 2D T1-weighted in sagittal-oblique sections at closed and open mouth and coronal sections at closed mouth (TR = 340 ms, TE = 16 ms, FOV = 15 cm, slice thickness = 3 mm, matrix $256 \times 192$) with an interslice gap of 0.5 mm. Sequential bilateral images with the subjects at both closed mouth and maximum opening mouth positions were made. The latter position was obtained by means of a wooden intermaxillary device at the same mouth opening distance as measured clinically.

The articular disk was directly identified, in sagittal-oblique images, as an area of hypointensity with a biconcave shape above the condylar structure and its position has been categorized according to literature data[7,14–16] as follows:

Superior (normal) disk position (N): Posterior band of articular disk located above the apex of the condylar head ("at 12 o'clock position") in both intercuspal and maximum opening mouth positions.
Disk displacement with reduction (DDR): Posterior band of the disk located anteriorly to the condylar head at the closed mouth position, but normal disk–condyle relationship established in maximal opening position.
Disk displacement without reduction (DDNR): Posterior band positioned anteriorly to the condyle either at closed or maximal opening mouth positions.

### 2.4. Statistical analysis

The relationship between MR-diagnosed disk position and the presence of clinical click sound has been assessed through $2 \times 2$ contingency tables as suggested in Finos and Salmaso.[17] In that work, a permutation test for a categorical variable in two-samples studies was introduced. This test is a decom-

position of the usual Chi-squared test for categorical variables in $2 \times K$ contingency tables, where $K$ is the number of categories of the categorical variable. The global Chi-squared test is decomposed in all possible $2 \times 2$ comparing the frequencies related to one category against the pooling of other categories. In such a way, it is possible to obtain partial tests allowing to investigate for the relative contribution of single categories to the rejection of the global null hypothesis. The dependence structure and the global test are handled by the nonparametric combination methodology suggested by Pesarin.[18]

## 3. Results

Table 1 reports the contingency table obtained by comparing the presence/absence of click sounds with the different magnetic resonance diagnoses.

A click sound has been clinically detected in 56/165 joints (33.9%) that have been classified as having a normal disk–condyle relationship by MR. Among the 90 DDR MR-diagnosed joints, click has been observed in 41 joints (45.6%), whereas in the remaining 49/90 joints (54.4%) no click sounds have been revealed. Among the 133 DDNR MR-diagnosed joints, the proportion of joints showing click was 65/133 (48.9%).

If click has to be considered positively associated with DDR diagnosis, we would expect the true proportion of joints with a MR diagnosis of DDR to be greater when click is present than when click is not present. To see this, we applied three partial tests, one for each category of the different MR diagnoses, according to Finos and Salmaso.[17] The results are shown in Table 2.

Joints with normal disk position showed to be negatively associated with the presence of click, MR diagnosis of DDR does not show any significant association (positive or negative) with click presence, and DDNR MR-diagnosed joints show a weak positive association with click sound, even though such association is not significant at a nominal level of 0.05/3 = 0.01667, which is the nominal level to account for multiplicity (i.e. the nominal level obtained by Bonferroni's correction).

The global test of independence between click and magnetic resonance diagnoses shows some weak significance against the null hypothesis (i.e. independence between the presence of click and the different MR diagnoses), with both the global test with Fisher's combining function, and the usual Chi-squared test significant at a 5% level (Table 3).

Summarizing the results, it can be concluded that there is a weak form of dependence between click and MR diagnosis, and that the MR diagnosis of DDNR seems to be more positively associated with the presence of click sounds than the other categories, which did not show significant positive associations with click (i.e. there is negative association between click presence and normal disk position and no association between click presence and DDR joints).

**Table 1 – Distribution of click and MR diagnoses**

| Frequencies | MR diagnosis | | | |
|---|---|---|---|---|
| Click | Normal | DDR | DDNR | |
| 0 | 109 | 49 | 68 | 226 |
| 1 | 56 | 41 | 65 | 162 |
| Total | 165 | 90 | 133 | 388 |

**Table 2 – Results of the partial test on each category of MR diagnosis**

| Partial tests | MR diagnosis | | |
|---|---|---|---|
| Category | Normal | DDR | DDNR |
| P-value | 0.996 | 0.239870 | 0.023976 |

## 4. Discussion

The clinical significance of temporomandibular joint sounds has been matter of debate for many years and joint sounds have been extensively investigated with both clinical and instrumental approaches.[19–22]

The study of TMJ sounds has been complicated by the objective difficulties of imaging the temporomandibular joint, which put technical problems due to its position with respect to other bony structures. The introduction of magnetic resonance imaging in the study of TMJ has allowed gaining a better insight into this joint,[10] thus having a strong positive influence on the TMJ literature.

Observations that about one-third of asymptomatic volunteers showed magnetic resonance signs of abnormal disk position[16,23] contributed a lot to reduce the importance of disk displacement in the clinical setting.

Conversely, there is much consensus that the presence of click sounds within the temporomandibular joint can not be considered a disease sign per se.[24]

Nonetheless, independently by their pathological significance, clinical signs have to be furtherly put into relation with imaging signs before achieving a full understanding of the complex relationship between clinical and imaging diagnoses of the temporomandibular joint.

The present investigation was an attempt to provide further data to such an issue, by assessing the association between the presence/absence of the clinical sign ''click sound'' and the different magnetic resonance diagnoses for disk position in a large sample of TMD patients.

Statistical analysis showed a weak dependance between the click sound and magnetic resonance diagnosis for disk position in general.

Moreover, in contrast with the study hypothesis that click sounds are expected to be more frequent in joints with reducing disk displacement, the magnetic resonance diag-

**Table 3 – P-values of the global test with combining functions and $\chi^2$ test**

| Combining function | Global test |
|---|---|
| Fisher | 0.02597 |
| $\chi^2$ | 0.02413 |

nosis which appears to be more positively associated with click sounds is disk displacement without reduction.

Indeed, even though the proportion of joints with reducing and non-reducing disk displacement that provided a click sound during the clinical assessment was similar (45.6% vs. 48.9%, respectively), the prevalence of the two MR diagnoses in joints with click sound were strongly different (25.3% vs. 40.1%, respectively).

These findings put into serious question the validity of click sound as a needed criterion for the clinical diagnosis of temporomandibular joint disk displacement with reduction.

Also literature data showed that no consensus has been reached yet among researchers as for the imaging correlates of click joint sound.

Taskaya-Yylmaz and Ogutcen-Toller[25] found a positive correlation between joint sounds and anterior disk displacement in a sample of 73 patients (131 joints) with internal derangement. Sutton et al.[26] reported that the condyle–disk relation was more likely to be normal in clinically silent joints than in those with audible sounds. Eriksson et al.[27] reported that click sounds characterize joints with reducing disk displacement, while joints with non-reducing disk displacement are usually silent or crepitating.

In accordance with those observations, also other studies suggested that a click sound can be considered an accurate indicator of disk displacement with reduction.[28–30]

By contrast, findings from the studies of Roberts et al.[31,32] did not support this conclusion, and reported that predictability of clinical diagnosis of internal derangement was quite low, ranging from 43 to 59% with respect to arthrographic findings.

Similar findings were reported by Yatani et al.,[33,34] who suggested that disk displacement with reduction can be diagnosed with clinical examination alone, but the accuracy of clinical findings to discriminate between reducing and non-reducing displacements is only acceptable.

Usumez et al.[35] reported that the presence of audible click sounds may be responsible for false positive diagnosis of disk displacement with reduction in joints that actually have a normal disk–condyle position or a disk displacement without reduction. Indeed, they described a click sound in 80% of normal joints, 89% of joints with disk displacement with reduction and 29% of joints with disk displacement without reduction.

Also Mueller-Leisse et al.[36] suggested that the presence of click sounds does not necessarily imply a reduction of displacement.

Moreover, in the study of Usumez et al.[35] the parameter ''presence of click sounds'' had a 1.5 positive likelihood ratio for disk displacement with reduction, that is much lower than the 7.8 LR described by Yatani et al.[33] for the parameter ''history of clicking''.

Findings from the present investigation are in line with those studies suggesting that a click sound within the temporomandibular joint is not an accurate predictor of disk displacement with reduction.

The disagreement between literature studies may be due to differences in patients' sample and data interpretation.

In particular, many studies' findings may have been influenced by the absence of a control group of healthy subjects. The lack of controls is the main limitation of the present investigation as well, since the inclusion of a non-TMD group should have made extrapolation of more representative data easier.

Nonetheless, literature data on volunteers with clinically silent TMJ have repeatedly showed that an anterior disk position at magnetic resonance is a frequent finding,[7–9] thus the presence of such a group in the present investigation should have been likely to decrease the DDR predictability by means of click sounds detection.

Moreover, the adoption of different statistical approaches might be partly responsible for non-homogeneous data interpretation among studies.

Future studies on this issue will have to take into account for the medio-lateral aspects of TMJ disk displacement. Indeed, partial displacements represent an intermediate step between normal disk–condyle relationship and DDR, but they are hardly detectable with clinical assessment alone.

On this purpose, some further clinical diagnostic techniques, such as the analysis of joint sounds during jaw opening following a condylar medio-lateral translation, might help improving the diagnostic agreement between clinical assessment and magnetic resonance imaging for this particular category of disk displacements and, hopefully, might provide convincing explanations for current controversies about the association between MR findings and certain clinical parameters.

## 5. Conclusions

Within the limitation of the present investigation, it can be suggested that:

- The presence of temporomandibular joint click sounds is not an accurate predictor of magnetic resonance diagnosis of disk position.
- The magnetic resonance diagnosis which appears to be more positively associated with click sounds is disk displacement without reduction.
- These findings put into question the validity of the presence of click sounds as a needed criterion for the clinical diagnosis of temporomandibular joint disk displacement with reduction.

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