

## Evaluation of aural manifestations in temporo-mandibular joint dysfunction

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### Evaluation of aural manifestations in temporo-mandibular joint dysfunction

Thirty patients with temporo-mandibular joint dysfunction were selected to investigate the changes in otoacoustic emissions before and after conservative treatment of their temporo-mandibular joints. Pure tone audiometry, transient-evoked otoacoustic emissions (TEOAE), distortion-product otoacoustic emissions (DPOAE) as well as a tinnitus questionnaire were administered to all patients before and after therapy. Therapy was conservative in the form of counselling, physiotherapy, anti-inflammatory agents, muscle relaxants, and occlusal splints. Results indicated insignificant changes in the TEOAEs, whereas there were significant increases in distortion product levels at most of the frequency bands. These results were paralleled to subjective improvement of tinnitus.

**Keywords** *temporo-mandibular joint dysfunction distortion-product otoacoustic emissions conservative treatment of temporo-mandibular joint dysfunction*

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In 1934, Costen described what has come to be generally known as Costen's syndrome. The syndrome included a variety of ear symptoms thought to be originating from temporo-mandibular joint (TMJ) disease. This variety included impaired hearing, stuffy ear, otalgia and tinnitus.<sup>1</sup> Costen proposed that the malpositioning of the mandibular condyle led to Eustachian tube blockage and thus, could result in such ear symptoms. Later, the tensor tympani hypothesis was introduced and entailed that the muscles of mastication and the tensor tympani are innervated by the trigeminal nerve and that hyperactivity of these muscles in TMJ dysfunction would cause ear symptoms through irritating the tensor muscle.<sup>2</sup> However, since tinnitus caused by tensor tympani muscle spasm is low-pitched, in contradistinction to the tinnitus experienced in TMJ dysfunction, this hypothesis was refuted.<sup>3</sup> The otomandibular ligament hypothesis was proposed and suggested that the aural symptoms are the result of direct mechanical stimulation of the malleus through the anterior malleolar ligament.<sup>3</sup> An argument against the ligament hypothesis was that the ligament cannot transmit enough energy to

account for the high frequency tinnitus and vertigo from local perturbations of the position of the malleus.<sup>4</sup> Lately, a direct effect of trigeminal innervation to the cochlear blood vessels was proposed. Consequently, it has been suggested that abnormal activity of the trigeminal ganglion projects to the cochlear blood supply and cause the ear manifestations described by Costen.<sup>5</sup>

Cochlear function was investigated in patients with TMJ dysfunction using the distortion product otoacoustic emissions (DPOAEs),<sup>6</sup> and results indicated that the distortion product levels were significantly lower in patients than their matched normal controls at some frequencies.

The aim of this study is to confirm the above findings of DPOAEs changes in TMJ dysfunction, and to demonstrate if there is some improvement in cochlear function after successful conservative treatment of the dysfunction.

### Materials and methods

#### MATERIALS

Thirty patients were selected from the outpatient clinic of the oral surgery department in Alexandria Faculty of Dentistry.

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The selection of patients was consecutive, given that they had fulfilled the criteria of inclusion in the study. Patients had no past history of ear disease or hearing loss, and they were divided in two groups. Group (A) of 15 patients having myofascial pain dysfunction syndrome. The patients fulfilled the criteria of this subdivision of the TMJ dysfunction syndrome which were: tender muscles of mastication, tender TMJ on palpation, deviation of the jaw when opened, pain in the pre-auricular region, and ear symptoms (otalgia or tinnitus). Group (B) of 15 patients with disc displacement with reduction, fulfilling the following criteria: clicking during opening or closing the mouth, and otalgia or tinnitus. MRI was done to assist in diagnosing patients of this group. Implementing the above criteria, 30 patients with TMJ dysfunction were selected with mean age of 24.3 years (range from 11 to 40 years). Twenty-five patients were women and only five were men. One man was included in group (A), and four in group (B).

#### METHODS

All patients were subjected to the following procedures:

1. Full dental and ENT history.
2. TMJ examination, including measuring the active and passive range of motion of the mandible.
3. ENT examination.
4. Audiological evaluation including:
  - (i) Pure tone audiometry at octave frequencies from 250 to 8000 Hz. The aim of this test was to include patients with normal hearing in the study in whom no other cause of tinnitus can be suspected other than joint dysfunction.
  - (ii) Impedance audiometry to verify the integrity of the middle ear system and as a pre-requisite to DPOAEs testing.
  - (iii) Otoacoustic emission (OAE) testing to investigate the cochlear function using the Otodynamics ILO96 system. This included the measurement of the transient-evoked otoacoustic emission (TEOAEs), and the DPOAE. For the TEOAEs, clicks were used as stimuli. Click level was 75 dB SPL. Probe stability was kept above 80%. The factors that were gathered from the TEOAEs were the overall reproducibility of response waveforms, in percentage, and

the band reproducibility at 1, 1.5, 2, 3 and 4 kHz, in percentage. For the DPOAEs, the DP-Gram was recorded for the 2F1–F2 product plotted as a function of the frequency of the second primary tone (F2). The stimulus intensity was 75 dB SPL with an F2/F1 ratio of 1.22. Measurements were done at three points per octave. The parameters that were derived from the DP-Gram were the DP levels in dB SPL at the different F2 frequencies.

5. Self-assessment questionnaire for tinnitus: an Arabic translation of the Tinnitus Handicap Questionnaire (THQ)<sup>7</sup> was answered by the patients. Permission for translating the questionnaire was obtained from the authors. The questionnaire includes 27 items that cover all aspects of tinnitus. The answer format was in a 'Yes or No' manner, and higher scores indicate more distressing tinnitus.
6. Conservative treatment of TMJ dysfunction:
  - (i) For group (A): counselling, analgesics, non-steroidal anti-inflammatory agents, muscle relaxants, physiotherapy and soft occlusal splints (night guard) were used.
  - (ii) For group (B): as above, but with hard acrylic occlusal splints.

#### Results

For group (A), all patients had otalgia before the start of treatment. After treatment, 10 patients became pain-free, and five of them had their pain improved from severe to mild degree. For group (B), eight patients became pain-free and seven had their severe pain improved to moderate level (3) or mild level (4). Table 1 shows the incidence of ear symptoms in the studied sample before and after treatment. Mantel-Haenszel test was significant for comparisons before and after therapy for both groups and for both otalgia and tinnitus.

Table 2 shows the results of pure tone audiometry before and after treatment. No statistically significant differences were found for audiometric thresholds at any frequency. Table 3 shows the comparison of TEOAEs reproducibility of response waveforms (in percentage) before and after therapy. Student's 't' test was not significant except for the

**Table 1.** The distribution of ear symptoms before and after treatment in both groups. Data are presented as number of ears

	Before treatment	%	After treatment	%	Statistical tests
Group (A)					
Tinnitus	6	20	1	3.33	MH = 3.98; <i>P</i> = 0.046*
Otalgia	17	56.7	3	10	MH = 14.7; <i>P</i> = 0.000*
Group (B)					
Tinnitus	6	20	1	3.33	MH = 3.98; <i>P</i> = 0.046*
Otalgia	17	56.7	3	10	MH = 14.7; <i>P</i> = 0.000*

\*Significant results at *P* = 0.05.

**Table 2.** Comparison of the results of pure tone audiometry in dB HL (mean and SD) before and after treatment

Audiometric frequency (Hz)	Before treatment	After treatment	't'-Test	P-value
250	19.1 (5.58)	19.1 (5.58)	NA	NA
500	17.3 (5.25)	18.0 (8.46)	0.626	0.536
1000	15.0 (6.69)	15.0 (6.69)	NA	NA
2000	12.3 (9.80)	12.3 (9.8)	NA	NA
4000	12.8 (7.95)	13.0 (7.83)	1.000	0.326
8000	18.0 (8.46)	17.8 (8.47)	0.197	0.845

4 kHz band. Table 4 shows the comparison of DPOAE levels before and after treatment. Results indicated that 't' test was significant with increased distortion product levels at seven bands (1257, 1587, 2002, 2515, 4004, 5043 and 6348 Hz).

Table 5 shows the comparison of the self-assessment questionnaire (THQ) before and after treatment. Results showed significant improvement of tinnitus as judged by the patients.

## Discussion

The American Academy of Oro-facial Pain defined TMJ dysfunction as a collective term including a number of clinical problems that involve the masticatory musculature, the TMJ and associated structures, or both.<sup>8</sup> The patients in this study were selected and classified into myofascial pain dysfunction disease or disc displacement with reduction according to the guidelines suggested by the academy. In this study, there were more women than men as the condition occurs more in females.<sup>9</sup> The present study showed an incidence of otalgia of 56.7% which agrees with the literature.<sup>10</sup> The incidence of tinnitus in this study was 20%, which is close to an incidence of 33% reported by Bush.<sup>11</sup> The present study showed no significant differences between hearing thresholds before and after therapy. This finding is quite conceivable since normal hearing was a selection criterion of the patients. The rationale was to make sure that patients had no organic ear disease that would explain tinnitus or otalgia.

**Table 4.** Comparison of the distortion product levels, in dB SPL, of the DP-Gram (mean and SD) before and after treatment

F2 Frequency	DP level before treatment	DP level after treatment	't'-Value	P-value
696	4.62 (3.82)	4.74 (1.18)	0.097	0.924
830	4.05 (3.75)	3.19 (3.95)	1.275	0.219
1001	6.20 (6.75)	9.3 (5.51)	1.677	0.112
1257	6.17 (7.49)	10.41 (3.68)	2.194	0.042*
1587	6.38 (5.77)	11.37 (3.97)	4.516	0.000*
2002	5.37 (7.04)	10.59 (5.24)	3.295	0.004*
2515	1.23 (6.34)	7.86 (6.15)	2.275	0.036*
3174	5.86 (5.51)	5.21 (5.15)	0.079	0.938
4004	6.16 (6.46)	6.32 (5.54)	2.571	0.020*
5043	14.47 (4.42)	17.50 (4.15)	2.588	0.019*
6348	8.40 (7.81)	13.22 (4.11)	3.929	0.001*

**Table 5.** Comparison of the scores of the Tinnitus Handicap Questionnaire before and after treatment

	Before treatment	After treatment	't'-Test and P-value
Mean	9.60	5.30	3.33
SD	3.86	1.25	P = 0.009*

Analysis of the TEOAEs revealed that there was no significant differences, except at 4 kHz, between the reproducibility of TEOAEs before and after conservative therapy. Despite this insignificant result which can be explained by the high standard deviations, one can observe that the overall reproducibility as well as the band reproducibilities increased by as much as 10% after therapy. This clinically observable difference could be attributed to the improved cochlear function after therapy. Analysis of the DPOAEs revealed a significant increase of DP levels, in dB SPL, after therapy at the frequency bands: 1257, 1587, 2002, 2515 and 6348 Hz. This increase in DP levels can be explained by improved cochlear function after therapy. Kikuchi *et al.*<sup>6</sup> reported the same finding at 2531, 3187, 4000 and 5031 Hz. The differences in the methodology of the present study from that of Kikuchi *et al.* may suggest why different frequency bands are demonstrating the trend. In the present study,

Frequency bands (kHz)	% Reproducibility before treatment	% Reproducibility after treatment	't'-value	P-value
Overall reproducibility	71.37 (24.36)	81.81 (15.09)	1.854	0.840
1.0	50.37 (42.45)	74.68 (30.06)	2.447	0.270
1.5	61.06 (40.03)	75.00 (29.76)	1.484	0.159
2.0	64.25 (77.81)	69.05 (30.80)	1.777	0.096
3.0	60.37 (37.33)	62.75 (37.17)	0.235	0.818
4.0	61.37 (43.45)	83.18 (23.04)	2.203	0.044*

**Table 3.** Comparison of the results of TEOAEs reproducibility of response waveforms, in percentage (mean and SD) before and after treatment

DPOAEs are compared before and after treatment from the same patients, whereas Kikuchi *et al.* compared DPOAEs in patients with DPOAEs in normal volunteers.

The tinnitus handicap questionnaire was used in this study to validate the results of the OAEs and as a subjective measure for the success of therapy. Results indicated a significant decrease of the scores after therapy which means improvement of tinnitus.

Vass *et al.*<sup>5,11</sup> demonstrated trigeminal innervation of the cochlear vasculature in guinea pigs. This innervation was demonstrated using an anterograde method by injecting the trigeminal nucleus with Biocytin. Twenty-four hours later, labelled fibers were found in the stria vascularis as well as the modiolar blood vessels. Similarly, retrograde transport of horse-raddish peroxidase, after its injection into the cochlea, was shown by finding labelled neurons in the trigeminal nucleus. This kind of innervation is thought to play a role in the normal vascular tone of the cochlear blood vessels, and may also provide a pathophysiological explanation for the ear manifestations occurring in trigeminal nerve irritation as in TMJ dysfunction.<sup>6</sup> The present study lends support to Vass *et al.*'s works by showing improved cochlear function after conservative treatment of TMJ dysfunction as evidenced by increased DP levels at most of the frequency bands tested. This objective improvement in cochlear function was paralleled by subjective improvement in tinnitus as evidenced by improved scores of the questionnaire.

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