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Temporomandibular disorders and their impact on the development of the overloading changes within temporomandibular joints

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Abstract: TMD is a disease within the masticatory system that increases its reach among the society every year in the third and fourth decade of life. The etiology of TMD is complex and it is often difficult to establish the cause in a specific case.
The aim of the study was to determine the impact of TMD on pathomorphological changes within the temporomandibular joints, evaluated in USG examinations and evaluation the assessment of differences in the number of pathological changes between various forms of TMD.
Material and Methods: The study material included a group of 386 patients, both sexes, aged 20 to 46 years, who came for prosthetic treatment due to symptoms of TMD. Ultrasound examination of the temporomandibular joints supplemented the clinical diagnosis of TMD in all the subjects. Axis I of the DC/TMD were used.
Results: Group I included 116 women and 89 men, group II consisted of 102 women and 79 men. Pathological morphological changes in the temporomandibular joints were found in all the examined patients. The changes in soft tissue structures were significantly increased in group II, but numerous pathomorphological changes were also present in the group of patients with the muscle form of TMD.
Conclusion: The results of the conducted studies with the use of USG temporomandibular joints revealed numerous pathomorphological changes within the temporomandibular joints. This indicates the usefulness of the USG examination in additional diagnostic tests in the group of patients with TMD.

Keywords: TMD, temporomandibular disorder, ultrasound evaluation, temporomandibular joint, pain, disc displacement with reduction, masticatory muscles.

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Introduction

Temporomandibular disorder (TMD) is a disease about complex, multifactorial and complicated etiology and concern with not proper functioning of masticatory system (masticatory muscles, temporomandibular joints and surrounding structures). Unfortunately TMD systematically increases its range among the population every year, in the third and fourth decade of life. There is a growing problem that the number of patients with the pain form of this disease is systematically increasing and the age of this group of the patients is getting lower [1–5].

Very important in the etiology is the patient's nervousness and psychoemotional disorders and pathological habits of biting and/or clenching teeth [6–9]. The term muscles hyperactivity, as well as various other oral habits are above that necessary for physiological function. Thus, there is a constant, significant increase in the tone of the masticatory muscles. Generally, sometimes it is difficult to establish the leading cause in a specific case. The role of dentist in the treatment of TMD is very important and spectacular. The prevention of these dysfunctions is still underestimated, that is why the number of TMD patients is increasing around the world. Until recently, we thought that the effects of the parafunctional activity occurring in the masticatory organ are only functional changes, but numerous results ultrasound examinations show that, unfortunately, they also result in serious structural changes in the temporomandibular joints [10–14].

The main symptoms of TMD are pain in the masticatory muscles and/or temporomandibular joints, limitations in the lowering of the jaw and the lateral movement, acoustic symptoms in the joints [2, 4, 6, 8].

In the treatment of TMD, usual occlusal splints are used and very important are physiotherapeutic therapy. The pharmacological treatment is concern with relaxation drugs and injection (botulinum toxin type A), painkillers and dietary supplements (glucosamine and chondroitin). The self-management is very recommended with regular exercises performed by patients and a number of other supportive methods [1, 3, 4, 10–14].

The main diagnostic method include: medical interview, clinical examination and picture diagnosis; magnetic resonance imaging or ultrasound examination [2].

Occlusal parafunction's activity in the form of grinding or clenching of the teeth are considered as an important role in the pathomechanism of TMD development and are considered to be one of the most important etiological factors, but not the only one. Prolonged contraction of the muscles during these pathological habits causes excessive loads occurring within the temporomandibular joints and displacement of the articular disc, most often in the anterior direction [4, 7, 10, 15–19].

Ultrasound examinations are a very valuable alternative to magnetic resonance imaging (MR). This is still a standard, but this examination is very expensive and

difficult to access for the average patient. In addition can be used in pregnant women and is much less burdensome for patients with claustrophobia, sensitive to noise and having a pacemaker [20–25]. The results of ultrasound examinations of the joints are very important and helpful for dentist in diagnosis and planning the stages of treatment accurate and detailed [26–29]. They include changes in the temporomandibular joints and masticatory muscles such as pathology of the articular surfaces, heterogeneity of the contour of the articulation surface, defective changes in the chondral surface, productive changes in the edge and articular surfaces, osteophytic production changes, abnormalities of the position of the articular disc — in occlusion and jaw opening. Ultrasonography offers many advantages, including reduced cost, accessibility, fast results, decreased examination time and lack of radiation exposure [30–34].

The research was inspired by a results of commissioned research in diagnostic procedures of TMD patients. Still the USG examination it is underrated and underused.

The aim of the study

The aim of the study was to determine the impact of TMD on pathomorphological changes within the temporomandibular joints, evaluated in USG examinations and evaluation the assessment of differences in the number of pathological changes between various forms of TMD.

Material and Methods

The study material included a group of 386 patients, both sexes, aged 20 to 46 years, who came for prosthetic treatment due to symptoms of TMD (pain of the masticatory muscles, limited opening of the mouth, popping and clicking in the temporomandibular joints) at the Department of Prosthetics. The USG examination of the temporomandibular joints were commissioned as supplemented the clinical diagnosis of TMD in all the subjects. Axis I of the DC/TMD (International Network for Orofacial Pain and Related Disorders Methodology; 2018) was used in the diagnosis of dysfunction [14–17].

The patients were divided into two groups; group I consisted of patients with the muscle form of temporomandibular disorders (form I a DC/TMD — myofascial pain), group II consisted of the patients with disc displacement with reduction (group IIa). In all respondents a functional examination of the masticatory system according to the DC/TMD procedure was performed, assessing the clinical parameters of the stomatognathic system in the form of an assessment of the range and symmetry of mandibular movements, mandibular lowering path, palpation of the masticatory muscles

and temporomandibular joints, acoustic symptoms in the temporomandibular joints and intraoral signs of occlusive parafunctions [1, 2, 6, 15, 23].

Additional examinations consisted of USG examination of the temporomandibular joints with the use of the Philips iU22 apparatus, high-resolution linear array transducer and the 9–16 MHz head of the type of hockey stick, which was arranged linearly, parallel to the course of the zygomatic arch. The ultrasound examination of the joints was performed in the position of the central occlusion of the mandible and at maximum opening of the mandible, as well as in the dynamic state. The articular disks were assessed during static and dynamic examination. The patients were sitting on a chair, with their back resting on the backrest and their feet on the floor [8, 9, 17–21].

The inclusion criteria for the studies were: appropriate age range of patients, good general health of patients, forms Ia and IIa according to the DC/TMD procedure, and consent of patients to participate in the studies. The exclusion criteria were the occurrence of general diseases that make it impossible to continue in the research, withdrawal of consent to participate in the project, and disease progression of illness to a more advanced form of TMD (IIb) [15–17].

Data were statistically analyzed using the Statistica 13.1. The Shapiro–Wilk test was used to check for normality of distribution. For comparisons of variables, parametric Student's t-test were used. The level of statistical significance was set at $p < 0.05$.

The study was approved by the Bioethics Committee of the Jagiellonian University (No. 1072.6120.57.2018, April 20,2018).

Results

Group I consisted of 116 women and 89 men, group II — 102 women and 79 men (Fig. 1).

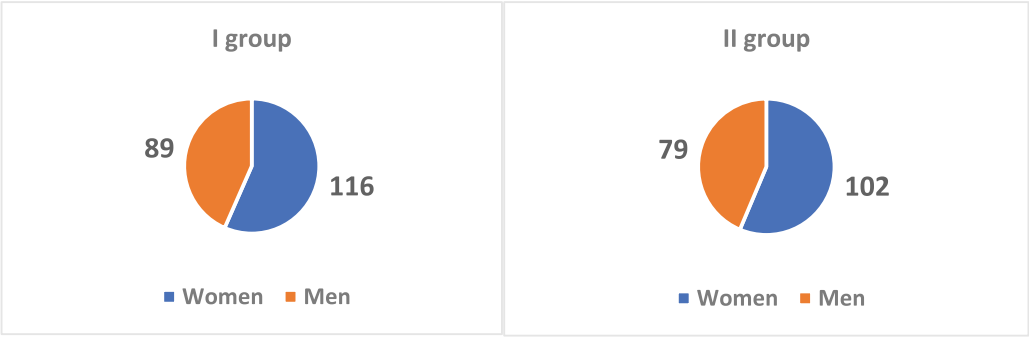

Fig. 1. Gender distribution of patients in both study groups.

Pathological morphological changes in the temporomandibular joints were found in all the examined patients. Tables 1 and 2 contain the results of the type of pathological changes within the temporomandibular joints and the number of patients (percentage rating) with these pathological alteration in left and right joint in both group. The changes in soft tissue structures were significantly increased in group II, but numerous pathomorphological changes were also present in the group of patients with the muscular form of TMD — group I.

Table 1. Results of the assessment of pathomorphological changes in the left temporomandibular joint in groups I and II in ultrasound examination.

Pathomorphological changes within the **left** temporomandibular joint	I group		II group	
	F/116	M/89	F/102	M/79
1. Heterogeneity of the contour of the articulation surface	32	22	39	31
	27.6%	24.8%	38.2%	39%
2. Defective changes in the cartilage surface	24	16	23	24
	20.7	18	22.5	30.4
3. Retrograde sclerotic lesions thickening the grade 1 subchondral layer	38	31	49	31
	32.8	34.8	48	39
4. Retrograde sclerotic lesions thickening the grade 2 subchondral layer	24	10	32	27
	20.7	11.2	31.4	34.2
5. Retrograde sclerotic lesions thickening the grade 3 subchondral layer	38	15	36	26
	32.8	16.9	35.3	32.9
6. Osteophytic changes penetrating the edge of the articular surfaces	16	16	16	19
	13.8	18	15.7	24.1
7. Defective changes in the cartilage surface	11	12	17	16
	9.5	13.5	16.7	20.3
8. Defective changes of the articulation surface	19	9	19	18
	16.4	10.1	18.6	22.8
9. Damaged ligament of the disc	21	9	20	13
	18.1	10.1	19.6	16.5
10. Abnormal shape of the articular disc	9	8	12	24
	7.8	9	11.8	30.4
11. Abnormal position of the articular disc in position of central occlusion	0	2	18	16
	0	2.2	17.6	20.3

Table 1. cont.

Pathomorphological changes within the **left** temporomandibular joint	I group		II group	
	F/116	M/89	F/102	M/79
12. Incorrect position of the articular disc in the position of the jaws fully open	1	5	29	32
	0.9	5.6	28.4	40.5
13. Capsule synovial hypertrophy	5	16	32	28
	4.3	18	31.4	35.4
14. Moderate synovial hypertrophy of the articular surfaces	10	9	33	32
	8.6	10.1	32.4	40.5
15. Excessive amount of fluid in the joint cavity	6	6	14	8
	5.2	6.7	13.7	10.1
16. Abnormal mobility of the articular heads	8	4	29	29
	6.9	4.5	28.4	36.7
17. Defective changes in the cartilage surface	12	11	24	25
	10.3	12.4	23.5	31.6
Average number of pathological changes within the joints	27.94		49.47	
p-value	0.0008			

Table 2. Results of the assessment of pathomorphological changes in the right temporomandibular joint in groups I and II in ultrasound examination.

Pathomorphological changes within the **right** temporomandibular joint	I group		II group	
	F/116	M/89	F/102	M/79
1. Heterogeneity of the contour of the articulation surface	31	21	35	23
	26.8%	23.6%	34.3%	29.1%
2. Defective changes in the cartilage surface	21	14	25	18
	18.1	15.7	24.5	22.8
3. Retrograde sclerotic lesions thickening the grade 1 subchondral layer	42	30	51	31
	36.2	34.8	50	39.2
4. Retrograde sclerotic lesions thickening the grade 2 subchondral layer	28	12	35	18
	20.7	13.5	34.3	22.8

Table 2. cont.

Pathomorphological changes within the **right** temporomandibular joint	I group		II group	
	F/116	M/89	F/102	M/79
5. Retrograde sclerotic lesions thickening the grade 3 subchondral layer	31	14	31	35
	26.7	15.7	30.4	44.3
6. Osteophytic changes penetrating the edge of the articular surfaces	15	14	18	21
	12.9	15.7	17.6	26.6
7. Defective changes in the cartilage surface	12	13	19	18
	10.3	14.6	18.6	22.8
8. Defective changes of the articulation surface	20	9	16	19
	17.2	10.1	15.7	24.1
9. Damaged ligament of the disc	18	11	24	34
	15.5	12.4	23.5	43
10. Abnormal shape of the articular disc	12	8	15	28
	10.3	9	14.7	35.4
11. Abnormal position of the articular disc in the position of the central occlusion	2	4	102	79
	1.7	4.5	100	100
12. Incorrect position of the articular disc in the position of the jaws fully open	3	7	0	0
	2.6	7.9	0	0
13. Capsule synovial hypertrophy	6	12	12	21
	5.2	13.5	11.8	26.6
14. Moderate synovial hypertrophy of the articular surfaces	12	8	34	28
	10.3	9	33.3	35.4
15. Excessive amount of fluid in the joint cavity	5	4	18	12
	4.3	4.5	17.6	15.2
16. Abnormal mobility of the articular heads	7	3	28	27
	6	3.4	27.5	34.2
17. Abnormal width of the joint space	12	9	35	20
	10.3	10.1	34.3	25.3
Average number of pathological changes within the joints	27.64		54.70	
p-value	0.0105			

Discussion

The temporomandibular joint is unique in both design and function. Joint diagnosis is difficult and requires not only specialist knowledge, but also modern diagnostic imaging methods. Ultrasonography is cost-effective and noninvasive imaging modality commonly employed for examination and imaging of tissues in medicine and veterinary medicine [1, 2, 5, 7, 24–26]. The imaging examination must be capable of providing the desired information of the internal anatomy or physiology of the joints and be a valuable addition to a clinical trial in TMD. It is characterized by high accuracy, because it enables the detection of changes in organs with small dimensions (from 0.1 mm) and the assessment of the functioning of soft tissue structures during movements in the joints [27–31]. It should be emphasized that nowadays ultrasound examination of temporomandibular joints is more accessible to patients compared to examination with the use of magnetic resonance imaging [32–35].

The results of the conducted studies shows an adverse trend indicating an unfavorable tendency, as even in the group of patients with the muscular form of TMD (Ia — according of DC/TMD) there are numerous, major pathomorphological changes in the temporomandibular joints, including third degree sclerotic changes 26.7% in women and 15.7% in men for the right joint and, respectively, 32.8% in women and 916.9% in men within the left joint. In the group of patients with TMD (IIa), the most advanced changes occurred in 30.4% of women and 44.3% of men for the right joint, and 35.3% of women and 32.9% of men for the left joint respectively. Considering also pathomorphological osteophytic changes, penetrating the articular surfaces, which occur in group Ia of patients in 16.8% of women and 18% of men in the left joint, and in group IIa in 15.7% of women and 24.1% of men respectively, this indicates a significant percentage of serious morphological changes in the joints in both groups. The analysis of the number of pathomorphological changes within the temporomandibular joints showed statistically significant differences between the compared forms of TMD, because in both compared groups, p was <than 0.005.

Without imaging examination of the joints, it could be assumed, that morphological changes would not occur in the muscular form of TMD. Until recently, we called these cases functional disorders. However, this is not the case, and the diagnosed changes indicate, the formation of in the anatomical changes of the structure under the influence of a significant overload of soft tissue [36–38].

This is a significant percentage, especially considering the muscle form, where it could be assumed that there will be no pathological changes in the joints at all. Overall, it should be summarized that all assessed changes occur in a much greater proportion in the group of patients diagnosed with IIa compared to group Ia, but extended diagnostics and rehabilitation should be used in both study groups.

Wright and Klasser [1], explains in their the textbook the close relationship between the development of pathomorphological changes in the temporomandibular joints and their prolong, excessive load, comparing the situation in the masticatory organ to pain in the knee joint and the patient's overweight. It can also be concluded that combating pathological habits of clenching or teeth grinding (usually lasting for many years) may be the key therapeutic procedure due to the elimination of excessive loads on the temporomandibular joints and the regression of pathomorphological changes in soft tissue structures.

In the publication from 2018 year, Surej Kumar *et al.* [35] emphasize that MRI is an expensive imaging method and contraindicated in certain patients, such as those with pacemakers, metal vascular clips and any metal particle in the body, or a significant, excess weight of the patient, claustrophobia. It is not without significance lower cost of the examination, which is an important element that determines the increasing frequency of using this diagnostic imaging method. The USG technique can be used in oral and maxillofacial region for the examination of bone and superficial soft tissue, detection of major salivary gland lesions, TMJ imaging, assessment of fractures and vascular lesions, lymph node examination, measurement of the thickness of muscles and visualization of vessels of the neck. Ultrasonography, which has shown high specificity, can supplement clinical evaluation in patients with temporomandibular joints disorders and can be used as a potential diagnostic tool for identifying internal derangement of the joints. USG identify structural abnormalities and disease mechanisms, associated with some of these disorders. Although there is remarkable progress in the imaging of the joints, no single imaging modality studied can accurately show all changes in the hard and soft tissues of the joint. It should be emphasized that the results of ultrasound examinations of the temporomandibular joints are very detailed and concern all soft tissue structures. The detection of significant pathomorphological changes in muscles and joints is very important for the full diagnosis of the patient, but also for the appropriate treatment planning, e.g. using intra-articular injections with hyaluronic acid, platelet-rich plasma or the use of other therapeutic methods [10]. The results of our own research indicate a significant percentage of morphological changes occurring even in the group of patients with the muscular form of TMD.

Klatkiewicz *et al.* [7] emphasize that for the detection of degenerative changes within the temporomandibular joints using USG, it includes: sensitivity, which is 94%, specificity is 100%, and accuracy in 94%. For joint's effusion changes, sensitivity was 81%, specificity was 100% and accuracy 95%, for changes in displacement of the articular disc, all the above parameters were 92%. Bas *et al.* [33] show that sensitivity of USG is 69% specificity 80% and accuracy is 71% in detection of internal derangements.

Opponents of this method conclude that it is not a good diagnostic method of temporomandibular joints due to low sensitivity and high specificity in the diagnosis of articular disc displacement — Dupuy-Bonafé *et al.* [36]. The adverse aspect of the

accuracy of the tests is the high dependence on the experience of the person performing the test and the lack of generally accepted standardization of steps and parameters related to specialized equipment. Díaz *et al.* [34] emphasize that the ultrasound examination of the temporomandibular joints may be a good tool to supplement the clinical trial today, not exposing patients to difficult access to the examination and high costs, as in the case of magnetic resonance imaging (MRI).

Surej Kumar *et al.* [35] points out that the limitation of ultrasound examinations is insufficient diagnosis of articular disc displacement in the mesio-distal plane, but according to the authors of this publication, the clinical trial provides sufficient data to diagnose this form of dysfunction. On the other hand, Díaz *et al.* [37] makes a point that ultrasound shows only the lateral parts of the articular heads, while the medial parts are unattainable for this visualization.

Fathy *et al.* [39] emphasize in their publication that ultrasound is a very good dynamic test, performed in real time, readily accepted by patients with TMD and valuable in diagnostics not only in the temporomandibular joints but masticatory muscles as well.

In summary, it should be emphasized that ultrasound examinations of the joints are a very valuable supplement to the clinical trial and facilitate the decision-making as to additional therapeutic methods that should be used in the case of pathomorphological changes in the temporomandibular joints and overloaded masticatory muscles.

Conclusion

The results of the conducted studies revealed numerous pathomorphological changes within the temporomandibular joints and the need for additional diagnostic tests in the group of patients with TMD.

Conflict of interest

None declared.

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Authors contribution statement

Research concept: Pihut M.; Carrying out the project (treating patients): Pihut M., Kulesa-Mrowiecka M.; Manuscript preparation: Pihut M.; Literature development: Kulesa-Mrowiecka M.; Preparing the article for printing: Gala A.; Submission of the article for publication: Pihut M.

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