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Joint noises and some internal derangements of the temporomandibular joint: A comparison study in specific subgroups

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Abstract
Introduction: *Joint noises have enormous clinical significance in the context of internal derangement of the temporomandibular joints. The relationship between joint noises and stages of internal derangements is not well understood.*
Goals: *Evaluate the frequency of joint noises, test the hypothesis that the frequency of joint noises including reciprocal clicking increases with the severity of internal derangement of the temporomandibular joints.*
Methods: *The clinical records of 135 subjects presenting with bilateral capsulitis, bilateral retrodiskal pain, bilateral disk-attachment pain, bilateral arthralgia and bilateral osteoarthritis that had been evaluated some years previously were retrieved and examined retrospectively regarding joint noises. At initial interview all subjects were examined comprehensively taking a history of the chief complaint, performing palpation of masticatory muscles and temporomandibul joints and using biomechanical tests to diagnose most types of Temporomandibular joint internal derangements. From January to May 2020, clinical records of subjects with bilateral capsulitis, bilateral retrodiskal pain, bilateral disk-attachment pain, bilateral arthralgia and bilateral osteoarthritis were retrieved from a database and evaluated retrospectively regarding frequency and type of joint noises.*
Results: *Ninety-six subjects= 71,1% of those in the TMJ-IDs subgroup had some type of joint noise as compared with 17/60=28,3% in the control subgroup (Fisher´s exact test p<0,0001). The frequencies of joint noises were as follows: Bilateral capsulitis (13/30=43,3%); Bilateral retrodiskal pain (20/30=66,7%); Bilateral disk-attachment pain (26/32=81,3%); Bilateral arthralgia (17/23=73,9%); bilateral osteoarthritis (20/20=100%); Controls (17/60=28,3%). The frequencies of joint noises were higher and statistically significant when comparing the bilateral retrodiskal and the Control subgroup (p<0,0007); the disk-attachment pain and the Control subgroup (p<0,0001); the arthralgia pain and the control subgroup (p< 0,0003) ; the ostearthritis and the control subgroup (p<0,0001); the osteoarthritis and the bilateral capsulitis subgroup (p<0,0001); the osteoarthritis and the retrodiskal pain subgroup (p<0,003) and the osteoarthritis with the bilateral arthralgia subgroup (p<0,02). Chi-squared for independence and for trends were used to test the hypothesis of independence of the subgroups and a trend for increase in the frequency of joint noises with the severity of temporomandibular joint internal derangements. The subgroups were independent (p<0,0003) an there was a trend for an increase in frequency with the severity of internal derangements of the temporomandibular joint (p<0,0001). The frequency of unilateral/bilateral reciprocal clicking increased from the bilateral capsulitis (2/30=6,7%) to the bilateral retrodiskal (12/30=40%), bilateral disk-attachment pain (21/32=65.6%) and bilateral arthralgia subgroup (16/23=69,6%): Chi-squared for independence (p<0,0001) and for trends (p<0,0001). Crepitus was observed exclusively in the bilateral osteoarthritis subgroup (20/20=100%).*
Conclusion: *Temporomandibular disorder subjects demonstrated a higher frequency of joint noises as compared with the control subgroup. Joint noises increased in frequency from the less severe to the severer subgroup with internal derangements. Reciprocal clicking was observed more frequently in intermediate and advanced stages of internal derangements of the tempromandibular joint. Joint noises were closely correlated with internal derangements of the temporomandibular joint.*
Keywords: *Temporomandibular disorders. Internal Derangements. Joint noises. Frequency. Early/advanced stages.*

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I. Introduction

The temporomandibular joint (TMJs) is a synovial joint composed by the condyloid process of the mandible which articulates with the squamous portion of the temporal bone or mandibular fossa. The articular eminence located anteriorly is also considered as articulating surface as its rare anatomy influences the downward and anterior movement of the mandibular head. or condyle[1]. The TMJ is a bilateral synovial articulation between the mandible and temporal bone that contains two joint spaces (upper and lower) separated by a disc formed mainly by fibrocartilage[2].

The joint disc is the most important anatomical and functional structure of the TMJ. The joint disk or meniscus is a biconcave fibrocartilaginous structure that divides the TMJ in upper and lower compartment [3]. The joint disc is endowed with histological and biomechanical properties believed to serve as cushioning and to distribute joint loads, promoting joint stability during jaw movements, facilitating lubrication and nourishment of the joint surfaces, preventing gross degenerative changes in the condyle and fossae[1]. During growth and development, the joint disk also serves to facilitate and induce growth, development and displacement of the mandible in different directions.

Temporomandibular Disorders (TMDs) or more recently Craniomandibular Disorders (CMDs) constitute collective terms used to describe a set of signs and symptoms of pain, movement and dysfunction that occur in the TMJs, masticatory muscles and adjacent anatomic structures. CMDs are characterized by a set of signs and symptoms including a complaint of pain, difficulties to perform jaw movements and joint noises. CMDs constitute a common condition that according to some studies, may be found n 28%[3] of the population, although only a small portion of those presenting with signs and symptoms actually seek treatment. CMDs is an umbrella term used to describe multiple disorders that occur within the TMJ structures, in the masticatory muscles (for instance, myofascial pain syndrome), or both[4].

Internal derangements of the temporomandibular joint (TMJs-IDs), constitute terms used to describe an abnormal anatomic and functional relationship between the joint disc, the mandibular fossa, the head of the condyle and the articular eminece.[5] . Such abnormal relationship is responsible for a set o signs and symptoms of dysfunction including joint and muscle pain, abnormal or irregular jaw movements, joint noises tenderness to palpation and sometimes headache. A TMJ-ID is usually associated with pressure, compression or displacement of the joint disk, inflammation of some joint components including the synovial membrane, retrodiskal structures and the joint capsule. The most important pathophysiological event in internal derangements of the TMJ is a progressive anterior displacement of the joint disk[1]. Based on anatomic, clinical, and radiologic observations TMJs-IDs have been classified in stages I, II,II, IV and V by Wilkes[6]. In such classification each stage is believed to be associated with increasing levels of clinically detectable mandibular dysfunction[7]. Thus, each stage is closely related with position, shape, displacement and deformation of the joint disk, level of inflammation and sometimes with age.

Although a complaint of joint noise not necessarily indicates treatment, this sign is closely related with the position, shape and displacement of the joint disk and sometimes with the lubrication status of the joint. According to Eversole and Machado[8], it has been documented that joint clicking and popping can be the consequences of anterior disk displacement. Clicking is more likely to be observed in early stages of TMJ-IDs[9] and during clinical examination clicking may occur during opening, closing or both (simple and reciprocal clicking). During auscultation of the TMJ, a joint sound can be heard in both asymptomatic (less frequently) and symptomatic individuals (more frequently).Disk injuries are the most common cause of TMJ-IDs. In the early stages of TMJ-IDs, a normal shape of the joint disk is frequently observed. However, with time, the displaced disk is deformed by thickening of the posterior band and reduction in the mass of the anterior band and the central thin area[3]. A joint noise is an important sign of CMDs, more specifically when other signs and symptoms are reported by patients. However, the relationship between TMJ joint noise and specific stages of TMJ-IDs is still not understood. Thus, this study was designed to:

1.Evaluate the frequency of joint noises in subgroups of TMDs individuals with ID;
2. Test the hypothesis that the frequency of joint noises increases with more advanced stages of TMJ-IDs;
3.Tes the hypothesis that reciprocal clicking is reported more frequently in more advanced stages of TMJ-IDs.
4.Test a third hypothesis that crepitus indicating tissue degeneration in those with TMJ-IDs, will only be observed in TMJ-OA subjects..

II. Material and Methods

Sample

In a period of 16 years, subjects with CMDs and BB were referred consecutively for diagnosis and potential treatment to the Department of Orofacial Pain UNIRG University in Gurupi, Brazil. Subjects were examined clinically and using a series of questionnaires to gather information about signs and symptoms of CMDs and BB and to obtain information about characteristics of the chief complaint. The TMJs and masticatory muscles were palpated, BB was diagnosed and biomechanical tests were used to diagnose the type of TMJ-ID. Joint noises were evaluated using subjects´ report, manual palpation during opening and closing the mouth and using a medical stethoscope. Data about anxiety, depression and somatization were also obtained using appropriate and valid questionnaires. Once the comprehensive examination and data gathering were carried out, data from all subjects was stored in a database for future research. From January 2020 to May 2020, the clinical records of those with bilateral capsulitis=Bil CAP (n=30), bilateral retrodiskal pain=Bil RP (n=30), bilateral disk-attachment pain=Bil DAP (n=32), bilateral arthralgia=Bil ART (n=23) and bilateral osteoarthritis of the TMJ (Bil OA=20), were retrieved and examined carefully to evaluate frequency and type of joint noises. Controls subjects (n=60) were those referred over the same period of time to the same facility but without the characteristics of CMDs. These subjects had been examined comprehensively in the same period of time using the same protocol. All subjects signed a formal consent allowing the researcher to use their material for research purposes. Confidentiality was guaranteed for all subjects.

Inclusion criteria for CMDs: A complaint of facial or TMJ pain, presence of joint noises, tenderness to palpation of muscles and joints, limitation of jaw movements and headache of musculoskeletal origin (referred from masticatory muscles and/or TMJs).

Inclusion criteria for capsulitis: Pain on gentle digital palpation of the joint capsule externally and anteriorly to the tragus during jaw opening and closing, pain on border jaw opening, pain that ceased immediately on closing the mouth, pain on moving the mandible laterally to the opposite side to purposely stretch the joint capsule and cause pain, absence of more advanced TMJs-IDs, for instance, retrodiskal pai and/or disk-attachment pain.

Inclusion criteria for retrodiskal pain: Pain when clenching the teeth in the maximal inercuspal position, pain when manipulating the mandible in the centric relation position, pain when the patient was instructed to move the mandible to the affected side, the pain induced by clenching the teeth in the intercuspal position ceases immediately when the patient is instructed to clench the teeth against cotton rolls placed over the posterior teeth, absence of a more advanced TMJ-IDs

Inclusion criteria for disk-attachment pain: Reports of intermittent periods of locking, progressive decrease in jaw opening, reciprocal clicking, and pain described as sudden, shooting or sharp.

Inclusion criteria for arthralgia: A long history of TMJ-IDs, pain described as burning, presence of joint noises including simple or reciprocal clicking and / or ill-defined crepitus.

Inclusion criteria for osteoarthritis: Patient is usually in the fifth or six decade of life, bilateral crepitus, patient´s report of previous signs and symptoms indicating previous stages of TMJ-IDs, for instance a description of burning, shooting or sharp pain

Inclusion criteria for the control subgroup: Absence of signs and symptoms of CMDs, presence of mild, moderate BB or no BB.

Bizarre joint noises: Included in this category were the joint noises described as follows: Unilateral simple click and unilateral "like" crepitus, bilateral reciprocal popping, unilateral simple click + simple unilateral crepitus, simple click + bilateral crepitus, bilateral reciprocal clicking and unilateral crepitus, unilateral or bilateral double crepitus.

Exclusion criteria: Subjects with severe psychiatric or psychological disorders, those with cognitive and learning difficulties, subjects unwilling to respond to questionnaires and those with motor disorders, for instance any type of epilepsy, were not evaluated comprehensively and thus, did not participate in this retrospective study.

III. Statistical analysis

Kruskal-Wallis and Dunn´ statistics were used to evaluate any statistical significant difference in age in the comparison of the subgroups. Chi-squared for independence and for trends were used to analyze data regarding an increase in frequency of joint noise from the less to the more severe subgroup with TMJ-IDs. Finally, Chi-square for independence and trends was also used to test independence of subgroups and to test the hypothesis that the frequency of reciprocal clicking increases from the Bilateral Capsulitis to the Bilateral Arthralgia subgroup. Fisher´s exact test was utilized in order to evaluate significant differences in the frequencies of joint noises when each TMJ-IDs subgroup was contrasted with the control one and when pairs of subgroups with TMJ-IDs were also contrasted. Significance was accepted if $p<0,05$.

IV. Outcome

This investigation evaluated subgroups of individuals presenting with bilateral capsulitis (Bil CAP=30), bilateral retrodiskal pain (Bil RP=30), bilateral disk-attachment pain (Bil DAP=32), bilateral arthralgia (Bil ART=23),bilateral osteoarthritis of the TMJ (Bil OA=20), and a control subgroup (n=60). There were 28 females and two males (93,3% and 6,7%) in the Bil CAP subgroup, 28 females and 2 males (93,3% and 6,7%) in the Bil RP subgroup, 32 females (100%) in the Bil DAP subgroup, 22 females and 1 male (95,6% and 4,4%) in the Bil ART subgroup, 20 females (100%) in the OA subgroup, and 46 females and 14 males (76,7% and 23,3%) in the Control subgroup. Mean age, standard deviation and range in these subgroups are described as follows: Bil Cap (30, 8,9 and 17-47); Bil RP (33,4, 12,5 and 11-60); Bil DAP (33,2, 10,5 and 17-51); Bil ART (43, 10,5 and 17-51, Bil OA (46,4, 9,3, and 16-70); Controls (34,2, 15,0, and 16-70), respectively. There was a statistical and significant difference in age when the subgroups were compared (Kruskal-Wallis and Dunn´ statistics p<0,0001): Bil CAP versus Bil ART (p<0,01); Bil CAP versus Bil OA (p<0,001); Bil RP versus Bil OA (p<0,01); Bil DAP versus Bil ART (p<0,05); Bil DAP versus Bil OA (p<0,01); Bil OA versus Controls (p<0,01). See Table 1 for further details.

The frequency of joint noises was about 13/30=43,3% in the Bil CAP subgroup; 20/30=66,7% in the Bil RP subgroup; 26/32=81,3% in the Bil DAP subgroup; 17/23=73,9% in the Bil ART subgroup; 20/20=100% in the Bil OA subgroup and 17/60=28,3% in the control subgroup. Fisher´s exact test was used to assess statistical significance when frequencies of joint noises were compared in pairs of subgroups: Bil CAP subgroup versus Control subgroup (p=0,16); Bil RP subgroup versus Control one (p<0,0007); Bil DAP subgroup versus Control one (p<0,0001); Bil ART subgroup versus Control one (p<0,003); Bil OA subgroup versus Control one (p<0,0001); Bil OA subgroup versus Bil CAP (p<0,0001); Bil OA subgroup versus Bil RP subgroup (p<0,003); Bil OA subgroup versus Bil DAP subgroup (p=0,07); Bil OA versus Bil ART (p<0,02). See Table 2 for further details. Because Chi-square for independence (p<0,0003) and Chi-squared for trends (p<0,0001), we can state that regarding frequencies of joint noises, the subgroups with TMJ-IDs in the current study, were independent and that the frequency of joint noises increased from the less severe (Bilateral Capsulitis) to the most severe (Bilateral osteoarthritis) subgroup.

Regarding unilateral reciprocal + bilateral reciprocal clicking in different subgroups with TMJ-IDs, as Chi-squared for independence (p<0,0001) and Chi-squared for trends (p<0,0001), we can state that the subgroups were independent and that there was a positive and statistically significant trend for an increase in the frequency of reciprocal click from an early to a late TMJ-ID stage. See Table 3 for additional details.

The most frequent joint noises observed in the current investigation among those with joint noises in different subgroups with TMJ-IDs were as follows: Bilateral capsulitis: 8/13 subjects= 61,5% demonstrated unilateral/bilateral simple clicking; Bilateral retrodiskal pain: 12/20=60% subjects demonstrated unilateral or bilateral reciprocal click; Bilateral Disk-Attachment Pain: 20/26=76,9% subjects demonstrated reciprocal clicking; Bilateral Arthralgia: 16/17=94,1% subjects demonstrated reciprocal clicking. Thus, unilateral or bilateral simple click was observed more frequently in the early stage of TMJ-IDs whereas reciprocal clicking was observed more frequently in advanced TMJ-IDs stages. Finally, crepitus was the predominant joint noise in TMJ-OA (20/20=100%). Bizarre joint noises were observed in all stages of TMJ-IDs, but the frequency was very low to merit further considerations. See Table 3 for additional details.

V. Discussion

Frequency of joint noises in TMDs-IDs

In the current investigation, a high frequency of joint noises was observed in the whole group of CMDs individuals with TMJ-IDs as compared with the control subgroup (96/135=71,1% versus 17/60=28.3%), respectively. Thus, this outcome is in line with one investigation[10] about diagnosis and treatment of CMDs asserting that a clicking, crepitus or locking of the TMJ accompanies joint dysfunction. Further, sophisticated methods of TMJ imaging show that joint clicking and popping can be the consequences of anterior meniscus displacement[8]. Clicking alone, however, should not be considered as a diagnostic element of articular disk displacement[11]. A popping or clicking sound is the most common noise the condyle makes as it moves under the anteriorly displaced disc[1] and indicates an anatomical obstruction to the normal and smooth anterior and inferior displacement of the condyle and disk. Regarding mechanisms of early joint dysfunction and development of joint noises, when the articular disk becomes displaced anteriorly, there is excessive pressure and then stretching of the highly innervated and vascularized retrodiskal tissues[12]. With time such tissues become compressed, inflamed and painful.

Noteworthy to mention is that simple click was observed in an early stage of TMJ-IDs, reciprocal clicking in early, intermediate and more advanced stages of TMJ-IDs, but crepitus was observed only in the most advanced stage of TMJ- IDs (TMJ-OA). This observation is in agreement with one investigation[13] reporting that patients with early TMJ-IDs stage complain of clicking sounds upon jaw opening and closing, pain is not a major complaint and if treatment is instituted, it should be carried out as conservatively as

possible. A clicking, crepitus or locking of the TMJ may accompany joint dysfunction. A single click during mouth opening may be associated with anterior disk displacement, a second click during closure (reciprocal clicking), indicates recapture of the displaced disk. Crepitus is a joint sound related to articular surface disruption usually reported or observed in patients with signs of symptoms of osteoarthritis[10]. It may be that continuous and progressive deterioration of the joint disk is associated with progression and development of more complex internal derangements. This assumption has echo in one investigation[12] asserting that TMJ-IDs progress slowly to degenerative disease. This is so as the adaptive capacity for adaptation of the TMJ is limited and some individuals may not adapt to structural derangements in the joint[14], for instance, inflammation, disk displacement and other anatomical and mechanical abnormalities.

The frequency of joint noises increased with the severity of TMJ-IDs.

Severity of TMJ-IDs is intrinsically associated with more severe changes in disk position and morphology. In turn, these changes alter the nature of joint noises. Thus, more frequent joint noises are usually observed in intermediate and advanced stages of TMJ-IDs. Joint noises also change in their characteristics with the severity of TMJ-IDs. This assumption is in line with one investigation[15] reporting that in TMJ-ID stage II, patients may report pain and limited range of motion. Joint noises may occur due to disc displacement or perforation and patients may develop crepitation in late stages of TMJ-IDs[15]. Further, one investigation[8] in patients presenting with TMJ-IDs reported that there is a tendency for a progressive worsening of a particular TMJ-ID. Not only the frequency but the characteristics of joint sounds are closely associated with the severity of TMJ-IDs. Patients may progress from joint sounds only through more advanced stages of TMJ-IDs in which pain, popping, clicking or locking give rise to crepitant sounds during patient auscultation.[8]. The frequency and type of joint sound may be one indicator to differentiate between inflammatory and degenerative derangements in both mild and advanced TMJ-IDs stages[13]. Studies[16] report that regarding some clinical symptoms in TMJ-IDs patients, including pain on palpation, joint sounds and subjective pain, only joint sound is related to the degenerative bone changes of the condyle observed using different imaging modalities. Because the frequency of joint noises in bilateral capsulitis was about 43,3%, 66,7% in bilateral retrodiskal pain and 100% in bilateral osteoarthritis, the outcome in the current study is reinforced by one investigation[17] asserting that in the early stage of TMJ-IDs, TMJ dysfunction and joint noise are not so evident, however, in more advanced stages of TM-IDs, a higher frequency of joint sounds including simple click, reciprocal click and crepitus are observed. These sounds are correlated with greater degree of deformation and displacement of the joint disc[17].

Because the concept of more advanced TMJ-IDs is intrinsically related with the concept of disk displacement, inflammation and deformation, one may expect to observe a higher frequency of joint noises in more advanced stages of TMJ-IDs. Consonant with this assumption, one investigation[6] indicates that "it is apparent that internal derangements progress to degenerative joint disease as the capacity of the joints to withstand insult is limited".

The frequency of reciprocal clicking increased from an early TMJ-IDs stage to a more advanced stage :

Reciprocal clicking is a joint nose that occurs both during opening and closing the mouth. The first click (during mouth opening) occurs as the posterior band of the disc slips back over the condylar head. The second click is heard during mouth closure as the posterior band of the disc slips forward off the condyle. The click is the result of friction between the posterior band of the disk and the condyle as they move in opposite directions and the disk returns to normal position relative to the condyle[18]. Other clicking sounds may also be produced by irregularities or defects in the surface of the disc or by changes in the convexity of the condyle and/or articular eminence[17]. In the current study, only some subjects demonstrated reciprocal clicking in the earliest stage of TMJ-IDs. However, in intermediate and more advanced TMDs, (with the exception of TMJ-OA), the frequency of such joint noise increased progressively. It may be that persistent parafunctional behaviors and other etiological agents cause sustained loading which with time, the joint disk and surrounding structures are not capable to withstand, thus, joint noises become more frequent and or change in type, for instance, from simple clicking to reciprocal clicking, to popping and other sounds. Disc disorders are intrinsically related to disk displacement an degree of inflammation. Congruent with these assumptions, one investigation[1] indicates that TMJ-IDs are often associated with inflammation of joint structures adjacent to the joint disc characterized by progressive anterior disc displacement leading to popping or clicking. In line with the outcome in the current investigation, one study[7] asserts that TMJ-IDs constitute common intra-articular joint disorder that may progress from TMJ-ID with reduction to TMJ without reduction. Implicit in this statement is the clinical observation that simple click may progress to unilateral reciprocal click, bilateral reciprocal click, disk displacement without reduction and then, crepitus.

This progress does not occur in all individuals with TMJ-IDs as there is great tissue variation in capability to adapt to injury[14]. Reciprocal clicking rather than simple clicking is more frequently observed in intermediate and advanced stages of TMJ-IDs. This is so as in the early stages of TMJ-IDs the disk retains its normal shape. Over time however, the degree of displacement and deformation increases[3] leading to higher

frequency of reciprocal click. The frequency and type of joint noise constitute a helpful tool indicating progression and sometimes assist in the diagnosis of certain types of TMJ-IDs, for instance, disk-attachment pain which is associated with higher frequency of reciprocal clicking. When the patient is not properly treated, TMJ-IDs get progressively worst, joint noises become more frequent, they may become bilateral and reciprocal clicking and inflammation worsen, the joint noise may disappear and osteoarthritic changes occur more frequently. In the current investigation, reciprocal clicking increased in frequency with the progression of TMJ-IDs and was observed more frequently in subjects with disk-attachment pain and bilateral arthralgia. Thus, this outcome is partially supported by one investigation[19] reporting that reciprocal clicking was the most common joint sound observed in the group with TMJ-IDs

The frequency of reciprocal click was higher in the subgroup with Bil-DAP (Bilateral disk-attachment pain). Thus, this outcome is in line with one study[8] indicating that in stage I TMJ-ID, a simple or a reciprocal click may be observed. However, in stage II, difficulties to open the mouth, more intense pain, transitory closed lock and reciprocal clicking are observed more frequently. Stage II internal derangement is characterized by periods of intermittent locking. Implicit in intermittent locking is the fact that this disorder or symptom is associated with higher degree of disc displacement, deformation and inflammation. Eversole and Machado[8] wrote that intermittent locking, reciprocal clicking and more intense pain are observed more frequently in stage II of TMJ-IDs. Thus, it is the abnormal interference of the joint disk during jaw movements that causes greater frequency of reciprocal clicking in this stage of TMJ-IDs. TMJ-IDs, usually progress to more advanced stages of joint dysfunction including pain and degeneration[10]. Thus, certain types of joint noises are observed more frequently in certain stages of TMJ-IDs. This is so, as disk displacement progresses with time and adaptation of the disk, capsule and adjacent joint ligaments is limited[10]. The highest frequency of reciprocal clicking was observed in subjects with bilateral disk - attachment pain or Bil DAP, a stage characterized by more intense pain, periods of intermittent locking and reciprocal clicking. One study[20] describes stage II TMJ-IDs as one stage characterized by "a hitting or obstruction of the joint disk" when opening is attempted. The disk obstruction may disappear spontaneously or the patient may be able to manipulate the mandible[20].

In the current study, we found a high frequency of unilateral or bilateral click in those with bilateral capsulitis, but a higher frequency of reciprocal clicking in those with bilateral retrodiskal pain. Thus, this outcome is in line with one study[21] indicating that in early stages of TMJ-IDs, no significant mechanical symptoms other than simple or reciprocal clicking, and no severe pain or limitation of motion and negative tomograms regarding osteoarthritic changes, are usually observed during careful examination.

The classification of TMJ-IDs in some stages of derangement is usually based in the position, shape and displacement of the joint disk. Thus, reciprocal clicking in stage II TMJ-ID is correlated with some deformation, displacement and less coordination with the joint condyle during opening and closing as compared with less or no deformation and displacement of the joint disk in stage I TMJ-IDs. These considerations are in accordance with one investigation[22] evaluating 217 joints in 165 patients with TMJ-IDs. Researchers reported that 26/86 joints in the anterior disc displacement with reduction group (ADDWR), progressed from stage I to stage II. In practical terms, this means an increase in frequency of reciprocal clicking from stage I to stage II TMJ-IDs. These researchers [22] evaluated disc status in those with reducing and nonreducing disc displacement longitudinally but for a short period of time (9,38 months). In their study, they described a progression in disk position, morphology and displacement according with the stage of TMJ-IDs as follows: Possible disk displacement without changes in disk morphology in stage 1; disk displacement with mild or moderate disc deformity in stage II, permanent disc displacement and changes in disk morphology in stage III, severe disc displacement and deformity in stage IV and severe disc displacement, perforation and disc deformation in stage V[22]. Regarding stages I e II, it is the mild or moderate deformity of the disc in stage II which increases the frequency of bilateral reciprocal click in subjects with bilateral disc-attachment pain.

The current study was cross-sectional. However, because we studied selected TMJ-IDs in well diagnosed subgroups with a specific disorders and we observed that age increased with the severity of the disorder or the progression of disk derangement, one is led to reason that there is a trend for a progression of TMJ-IDs. Thus, certain disorders progress to more advanced stages of TMJ-IDs. This progress is paralleled by changes in disk position and shape. Thus, simple click progresses to reciprocal click and non reduced disk to osteoarthritis discs. Providing support for this line of reasoning, one longitudinal investigation[22] about changes in disc status, reported that with time the disc continued to be more anteriorly displaced and tended to deteriorate. Researchers also observed that 26/86 joints=30,2% in the subgroup with anterior disc displacement with reduction progressed from stage I to stage II. In the current study, the frequency of reciprocal click was about 13,3% in capsulitis/synovitis, increased to 40% in bilateral retrodiskal pain and then to 76,9% in those with disk-attachment pain.

Such findings indicate progression of disk displacement and probably deformation of the joint disk from stage I to stage II. Consequently, the outcome in the current investigation is congruent with one study[23] indicating that once capsulitis and synovitis of the TMJ develop, it is difficult to resolve because the joint is constantly being used, resulting in further damage and synovial inflammation. Not all cases presenting with sign and symptoms of early stages of TMJ-IDs progress to more advanced TMJ-IDs with time as reducing disc displacements can also remain constant for many years[17]. Westling and Mattiasson[24] carried out an epidemiological study to evaluate joint noises in a nonclinical population of adolescents. They found positive correlations between reciprocal clicking and difficulties in opening the mouth, pain on movement of the jaw, chewing difficulties and jaw locking. The pattern of correlation between reciprocal clicking and signs and symptoms observed in the group of adolescents indicates that there is a close relationship between reciprocal clicking and TMDs-IDs Their study indicated that all four girls who reported intermittent locking of the mandible and several other symptoms of dysfunction had reciprocal clicking at the time of examination and positive signs or symptoms of TMJ-IDs.

Sato and Associates[25] evaluated 24 patients with a diagnosis of disc displacement with reduction previously referred to a Department of Oral Surgery in Japan. These 24 patients were selected for no treatment from a larger sample of 321 patient. Patients were followed during a period of 25,8 months. They found that pain decreased in 4 subjects with disc displacement, reciprocal clicking disappeared in 5 out of 24 individuals with such joint noise and remained unchanged in 19 subjects. Data from this investigation indicate that pain and reciprocal clicking may disappear in some individuals but may remain constant in others. Lundh et al[26] examined 23 patients with disc displacement with reduction and reciprocal clicking who were kept in observation during 52 weeks and received no treatment. They observed that reciprocal clicking disappeared in 2/23 subjects after 6 weeks and jaw locking developed in 1/23 patients after two weeks. The reciprocal sound remained unchanged in other patients. Data in such study indicate that in many subjects reciprocal clicking is resistant to change. Those findings are reinforced by data in the current study demonstrating that reciprocal clicking was observed in all stages of TMJ-IDs with the exception of TMJ-OA in which crepitus was observed in all subjects of such subgroup. Because in the current investigation we observed the presence of reciprocal clicking in the subgroups with Bil RP, Bil DAP and even in those with TMJ arthralgia, this outcome is not in line with the studies of Bisi and colleagues[27]. Such researchers reported that "joint sounds occur more frequently in cases of disk displacement with reduction". This discrepancy is explained by the fact that such researchers evaluated TMDs individual rather than subgroups of TMD subjects with different TMJ internal derangements. Further, they did not evaluate neither subjects with disk-attachment pain nor those with TMJ-arthralgia.

VI. Conclusion

Even thought subjects in the current investigation were comprehensively evaluated using a rigid protocol and were assigned to well diagnosed subgroups, we have to acknowledge that the subgroups with bilateral arthralgia and bilateral OA were not so large. This inconvenient may limit to some extent the generalization of some observations in the current investigation. With these considerations in mind, the study is valid regarding the following observations:

1. All clinical subgroups with TMJ-IDs demonstrated a high frequency of joint noises;
2.The type of joint noise changes from the early to late stages of TMJ-IDs;
3.Reciprocal clicking is observed more frequently in intermediate and late stages of TMJ-IDs;
4. Reciprocal clicking was rarely observed in subjects with TMJ-OA
5.Joint noises were observed with some frequency in the Control subgroup without TMDs;
6.The high frequency of joint noises in intermediate and late stages of TMJ-IDs indicate that joint noises are directly related with disk displacement, inflammation and deformation and thus, with the progression to more advanced stages of TMJ-IDs

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Table 1: Social and demographic data in experimental and control subjects

	SUBGROUPS					
	BIL CAP n=30	BIL RP n=30	BIL DAP n=32	BIL ART n=23	BIL OA n=20	CONTROLS n=60
	n %	n %	n %	n %	n %	n %
GENRE						
Females	28 93,3	28 93,3	32 100	22 95,6	20 100	46 76,7
Males	2 6,7	2 6,7	0 0	1 4,4	0 0	14 23,3
Totals	30 100	30 100	32 100	23 100	20 100	60 100
AGE						
Mean	30	33,4	33,2	43	46,4	34,2*
SD	8,9	12,5	10,5	10,5	9,3	15,0
Range	17-47	11-60	17-51	17-51	16-70	16-70

* Kruskal-Wallis and Dunn´ statistics (p<0,0001): Bil CAP versus Bil ART (p<0,01); Bil CAP versus Bil OA (p<0,01); Bil DAP versus Bil ART (p<0,05); Bil DAP versus Bil OA (p<0,01); Bil OA versus Controls (p<0,01).

Table 2: Frequency of joint noises in different subgroups: Bil CAP (n=30), Bil RP (n=30), Bil DAP (n=32), Bil ART (n=23), Bil OA (n=20), Controls (n=60).

	TMJ-IDs					
JOINT NOISE	Bil CAP 30	Bil RP 30	Bil DAP 32	Bil ART 23	Bil OA 20	Controls 60
	n %	n %	n %	n %	n %	n %
With*	13 43,3	20 66,7	26 81,3	17 73,9	20 100	17 28,3
Without	17 56,7	10 33,3	6 18,7	6 26,1	0 0	43 71,7
Totals	30 100	30 100	32 100	23 100	20 100	60 100

*Fisher´s exact test comparing frequencies of joint noises in pairs of subgroups:
Bil CAP subgroup versus Control subgroup (p=0,16); Bil RP subgroup versus Control one (p<0,0007); Bil DAP subgroup versus Control one (p<0,0001) Bil RT subgroup versus Control subgroup (p<0,003); OA subgroup versus Control one (p<0,0001); OA subgroup versus Bil CAP subgroup (p<0,0001); OA subgroup

versus Bil RP subgroup (p<0,003); OA subgroup versus Bil DAP subgroup (p<0,07); OA subgroup versus Bil ART subgroup (p<0,02).

Table 3: Frequencies of different joint noises in subgroups with TMJ-IDs.

	SUBGROUPS WITH TMJ-IDs											
JOINT NOISES	BIL CAP 30		BIL RP 30		BIL DAP 32		BIL ART 23		BIL OA 20		CONTROL 60	
	n	%	n	%	n	%	n	%	n	%	n	%
Unilateral/bilateral simple click	8	61,5	7	35	2	7,7	0	0	0	0	8	13,3
Simple + reciprocal click	0	0	0	0	2	7,7	0	0	0	0	0	0
Unilateral reciprocal click*	0	0	4	13,3	1	3,1	0	0	0	0	3	5
Bilateral reciprocal click*	2	6,7	8	26,7	20	76,9	16	94,1	0	0	5	8,3
Unilateral click+ Unilateral reciprocal click	2	6,7	0	0	0	0	0	0	0	0	0	0
Unilateral click + unilateral crepitus	0	0	0	0	0	0	0	0	2	10	1	1,7
Unilateral click + Bilateral crepitus	0	0	0	0	0	0	0	0	1	5	0	0
Simple or reciprocal bilateral crepitus	0	0	0	0	0	0	0	0	16	80	0	0
Bizarre noises	1	3,3	1	5	**1**	**3,8**	1	5,9	1	5	0	0
TOTAL FREQUENCY	13	43,3	20	66,7	26	81,3	17	73,9	20	100	17	28,3

*Chi-squared for independence comparing frequencies of unilateral + reciprocal click in different subgroups (p<0,0001). Chi - squared for trends (p<0,0001).

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