Prevalence of TMJ Symptoms in Traumatized Patients Previously Treated for Mandibular Fractures "Retrospective Study"

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Abstract: Introduction: Indirect trauma to the temporomandibular joint（TMJ）can lead to temporomandibular disorders（TMD) because the mechanisms by which indirect trauma develops to TMD are unclear. Joint problems due to indirect trauma can cause immediate or delayed symptoms, which are often misdiagnosed . **Aim of the work:** The present work is a retrospective study aiming at evaluating the persistent TMJ symptoms in previously treated patients suffering from mandibular fractures. **Materials and Methods**: 30 patients with condylar and subcondylar fractures due to direct or indirect blows with or without associated mandibular fractures were treated by reduction and fixation. The patients were monitored after at least 6 months for persistent TMD using clinical examination, subjective and functional indices and correlated to MRI findings. Symptomatic joints were treated and re-evaluated. **Results:** The results proved that indirect trauma showed greater correlation with TMD as compared to direct trauma. This is more obvious when the trauma did not cause condylar or subcondylar fracture. MRI confirmed the results positively where findings as joint effusion of TMD conformed with clinical findings and helped in designing treatment plan. **Conclusion**: Before treating condylar or subcondylar fractures, the condition of the TMJ should be evaluated at the time of injury regarding the presence of soft tissue inflammation within the joint, fluid effusion or disc involvement. Adequate realignment and fixation of the fractured bone is not enough for avoiding or treating the progressive TMD associated with the injury.

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1. Introduction

The temporomandibular joint (TMJ), derives its name from being that joint connecting the temporal bone of the skull with the mandible, and is also known as "jaw joint". This joint is a major functional joint despite its small size compared with many other joints in the body. It allows opening and closing of the mouth; and thus have an important significant effect on the oral functions ranging from eating, talking, laughing, swallowing and yawning. Proper function of the TMJ therefore, requires a harmonious and coordinated function of the teeth, the muscles, and the joint itself[1].

The TMJ differs from other body joints producing single movement. It functions through both a rotational or hinge-type movement, and also in translational or sliding type of movement. Translation is necessary for the jaw to move forward, slide side-to-side, and to open widely. Abnormalities of the disc, which restrict translational movement, cause pain or restriction of these movements. The entire joint is enclosed in a soft tissue envelope known as a capsule[1-4].

The TMJ is commonly traumatized directly or indirectly by blows to the face sufficiently violent to fracture the facial skeleton[2]. Direct blows may produce traumatic lesions to the TMJ associated with condylar fracture as following a violent chin trauma, while indirect blows result in lesion such as TMJ effusion ollowing a car accident as in cervical whiplash trauma. The effects of direct trauma on the TMJ are well-documented in the literature, and depend upon the intensity, direction and area of the impact, ranging from mild contusions to severe and rarely described cases of condyle penetration into the middle cranial fossa[2-4]. Post-traumatic lesions may be as severe as ankylosis, and surgical corrections are consequently needed[5].

The posterior region of the mandible is involved in a high percentage of mandibular fractures, predisposing the soft tissues of the TMJ to injury[6].

Indirect traumas have been pointed out to be an important cause of temporomandibular disorders (TMD) that can lead to its damage. Some studies suggested the co-occurrence of a mandibular whiplash with a car-accident cervical whiplash, on the basis of the hypothesis that "the extreme hypertranslation of the condyle out of the glenoid fossa might lengthen or even stretch the posterior attachment and the ligaments, both at the medial and lateral levels", thus predisposing to disk displacement and post-traumatic joint tenderness and effusion[7]. The mechanisms by which indirect trauma develops to TMD have been in debate, which influences the preventive and treatment procedures, particularly that misdiagnosis of these TMJ injuries happens often despite its frequent occurrence[6-8].

Cooper and Cooper[3] stated that "joint problems due to indirect trauma can cause symptoms immediately, or after a significant delay". Documentation and follow-up of the presence of post-traumatic inflammatory TMJ arthropathy should not be overlooked. The potential injurious effects of an untreated ongoing inflammation can lead to pain disorders, TMJ dysfunctions, and meniscus derangement all being complex disorders difficult to diagnose precisely and treat effectively[9-11].

Epstein et *al.,* [12] stated that direct or indirect trauma from motor-vehicle-collision (MVCs) has been associated with musculoskeletal pain in the head and neck including TMDs, as well as other phenomena such as headache and neuropathic pains. Accordingly, it has been advocated that dentists should be aware of their ultimate role in the recognition, diagnosis and management of injuries and pain following motor-vehicle-related trauma.

It was suggested that although some TMJ injuries do resolve spontaneously, however, some patients present later with internal derangement particularly in the non-fractured side in unilateral fracture[9].

A comprehensive diagnostic work-up including appropriate history, examination of the head and neck, supplemented by diagnostic imaging should be undertaken to determine whether a patient victim of a MVCs collision has TMD. Imaging could range from pantomograph for screening bony abnormalities, cone beam computed tomography scanning for more detailed bony assessment and magnetic resonance imaging for soft tissue abnormalities[12].

Treated fractured associated with TMJ in MVCs collision, whether conservatively or surgically treated should be followed-up. It is of utmost importance in clinical trials and in unsuccessfully treated patients to examine whether the residual pain is caused by joint abnormality, masticatory muscle disorder or occlusion[10].

Several studies are concerned with problem of issuing a standardized classification for TMD's signs and symptoms. It was thought that the use of indices is an excellent mean to individually classify the disease relevant to its severity, in order to examine the incidence of such problem in a specific population, measure the effectiveness of the therapies employed and study etiologic factors[13,14]

Helkimo[15] was a pioneer in developing indices to measure the severity of TMJ disorders, as well as pain in this system. The Helkimo dysfunction indices Ai and Di are tools to gather the different symptoms and signs into one particular index value. Helkimo in 1974 specified the dysfunction by its symptoms: pain, tenderness, limited function, and TMJ sounds. The indices he created are still widely used in epidemiological studies[16,17].

Regarding diagnostic imaging of the TMJ Hu et al., [18] advocated that MR imaging is one of the most superior imaging modality for diagnosing TMJ disorders and diseases, since MRI can be used to investigate both hard and soft tissue injuries of the TMJ, which is important in understanding the pathogenesis of indirect trauma on the TMJ . Accordingly, the presence of joint fluid, disc position and morphology, articular disc dislocation, articular capsule abnormality, as well as cortical bone and bone marrow condition in the indirect injury of temporomandibular joint without condylar fracture could be clearly assessed. [19,20].

2.Patients and Methods:

The scope of the study was based on thirty patients previously treated in the inpatient department of the Faculty of Dentistry, Alexandria and Suez Canal Universities for fractures of the mandible associated with condylar and/or subcondylar injuries using either open or closed reductions all stabilized with rigid fixation (RF) with and/or maxillomandibular fixation (MMF).

Inclusion data consisted of a clear connection between an either direct or indirect traumatic event leading to mandibular fractures treated at least 6 months ago.

The patient was considered a bearer of a temporomandibular disorder (TMD) when he/she presented at least one of the following complaints: TMJ pain; mouth opening limitation; intra-articular noise.

A comprehensive history was taken including both a medical and a dental history. The history included detailed questioning relating to the individual's pain; onset, severity, duration, progression, aggravating and easing factors, and location. Details about painful movements, pain on opening or closing the mouth, and pain on chewing. Symptoms such as crepitus, clicking, locking, or muscle tenderness were assessed. Joint noises were examined by auscultation over the TMJ.

The TMJ was palpated, by placing a finger in the external auditory meatus, to determine if tenderness suggestive of capsular inflammation was present.

An Informed Consent Form was signed after the patients had been properly informed of the content of our research. A questionnaire form was structured including the personal data and the results of the Helkimo and the *clinical dysfunction* indices[21]. The data assessment was mainly based on Helkimo´s anamnestic index for subjective symptoms (Ai) and an examination for clinical signs using the clinical dysfunction index (Di):

Symptoms of TMD were assessed according to the Helkimo anamnestic index (Helkimo, 1974), which has three grades: Ai0 = no symptoms and AiI = mild symptoms such as TMJ sounds, feeling of fatigue in the jaws, and feeling of stiffness in the jaws on awakening or on movement of the lower jaw. AiII = severe symptoms like difficulties in opening the mouth wide, locking, luxations, pain on movement of the lower jaw, pain in the region of the mandible or in the TMJ area.

The clinical dysfunction index (Di) which is considered a functional evaluation of the masticatory system was based on the evaluation of five clinical signs: impaired range of movement, impaired function of the TMJ, muscle pain, TMJ pain, and pain on movement of the mandible. In accordance with the presence and/or severity of these clinical symptoms, individuals are assigned a score of 0, 1, or 5 points. According to the score attained, the individuals were classified in four groups: Di-0: 0 points - Individuals clinically free from dysfunction symptoms; Di-I: 1 to 4 points - Individuals with mild dysfunction symptoms; Di-II: 5 to 9 points - Individuals with moderate dysfunction symptoms; Di-III: 10 to 25 points - Individuals with severe dysfunction symptoms[21].

The data was collected, tabulated and statistically analyzed. Clinical findings were correlated to the MRI findings.

MRI assessment:

T1- and T2-weighted MRI Images were made in an open- and closed-mouth position in the sagittal plane as well as in a closed-mouth position in a coronal plane. The imaging was performed on a sigma 1.5 Tesla magnet spin echo sequence, with slice thickness 3 mm. Direct sagittal images were obtained using axial localizer image and head coil for bilateral examination of both joints If any fluid density was identified within either joint space in the open- or closed-mouth T2-weighted images, they were interpreted it to represent an effusion.

According to the correlated clinical, functional and MRI findings, the patients were allocated to two treatment groups:

- Group I Asymptomatic group: with negative clinical, functional and MRI findings of persistent TMJ problems.
- Group II Symptomatic group: with one or more positive clinical symptoms pertinent to TMJ dysfunction with or without associated MRI findings.

Conservative treatment was planned for group II: anti-inflammatories and analgesics were given. Occlusal analysis and equilibration was complemented by an anterior repositioning occlusal appliance following Okson',s[21] simplified fabrication technique for 3-6 weeks. The appliance was fabricated as thin as possible, adapted in the patient's mouth and the patient was asked to open and close, to assure that during contact of opposing anterior teeth with the appliance anterior slope the posterior teeth were closed but not actually contacting the opposing portion of the appliance. Readjustments of the appliance to optimal occlusal conditions was performed upon need in the weekly appointments. The patients were reassessed 3 months post-operatively .

3.Results:

The results of the clinical data: including the patients' age, gender, cause and site and distribution of injuries showed that males (60%) were more affected than females (40%). The patients ages ranged from 19-58 years (mean 38.5) (Fig 1). The etiology of fracture was mainly due to road traffic accident (24 patients, 80%).

Indirect trauma (83.3%) constituted the main blow directed to the condylar region in comparison to direct trauma (16.6%) (Fig 2). The indirect trauma was associated with unilateral dislocation in 3 patients (10%) and displacement in10 patients (30 %) with or without additional fracture, no displacement in 15 patients (50 %) with or without additional fracture and bilateral dislocation in 2 patients (6,66%) as presented in (Table 1 and Fig 3).

The clinical subjective symptoms and function tests were collected and summarized in (Tables 2 & 3 and Figs. 3 & 4). Females showed more severe symptoms and dysfunctions than males whom symptoms and dysfunction were milder.

Although Statistical analysis using the chi-square tests between the direction of the blow and Anamnestic index (Table 4) and dysfunction tests revealed no significant difference, however, a positive correlation could be noticed regarding the more severe clinical symptoms and dysfunction in relation to indirect trauma (Tables 4 & 5).

While regarding the direction of the blow indirect trauma was mainly associated with undisplaced fractures (Table 6)

Subjective assessment of the degree of the TMJ injury was carried out through correlating the clinical and MRI findings. Joints involvements with persistent symptoms showed direct correlation to the initial type of injury as evidenced by the cases with bilateral subcondylar fracture cases associated with unilateral dislocation. Persistent clinical and dysfunction symptoms were related to the dislocated side and revealed by the TMJ MRI findings showing reduced signal intensity diagnosed as joint effusion with anterior disc displacement (Fig. 1). On the other hand, the least clinical complaints and MRI findings were associated with the cases with bilateral subcondylar fractures without dislocation (Fig. 2).

The worst findings were associated with the undisplaced subcondylar fractures (Fig. 3) specially when the direction of the blow was indirect as reported in the history, where the patients manifested symptoms ranging of pain, clicking and deviation.

Females showed predominance of severe symptoms since 6 patients representing 50 % of the whole female group post-injury group (Table 2) suffered severe symptoms (AiII) while 4 females (33.3 %) of the whole female group suffered from severe dysfunction (Di-III) (Table 3).On the other hand, only 2 male patients representing (11.1%) of the whole male group fell in the severe symptoms group (AiII) having persistent symptoms requiring treatment (Table 2).

2 Two female cases (16.6 %) of the female group showed actual changes with disc displacement in MRI (Fig 4) together with associated severe dysfunction indices (Table 3) while, 2 male cases representing (11.1%) of the male group had severe dysfunction with MRI changes (Fig. 5).

The patients appointed to the symptomatic group were subjected to conservative treatment as previously described treatment and were re-evaluated for signs of progressive resolution of symptoms or persistent discomfort. All patients showed degrees of improvement ranging from complete resolution of symptoms to relative improvements (Fig. 6). However, 2 cases showed non-responsive persistent symptoms

Table 1: Clinical subjective symptoms

Site & distribution of injury	Gender		Displacement or dislocation	Direction of blow	Treatment of condylar fracture	Treatment of associated fracture
	M	F				
Bilateral subcondylar fracture and symphysis fracture with bilateral dislocation and unilateral displacement (2 pt 6,66%)	1	1	Bilateral dislocation (2 pt 6,66%) Unilateral displacement (1 case 3,33%)	Indirect (2 pt 6,66%)	OR and RF (2 pt 6,66%)	CR and MMF (2 pt 6,66%)
Bilateral undisplaced subcondylar fracture and symphysis fracture with unilateral dislocation (3pt 6,66%)	2	1	unilateral dislocation (3 pt 10%)	Indirect (3 pt 10 %)	OR and RF (1 pt 3,33%) & CR and MMF (2 pt 6,66%)	CR and MMF (3 pt 10%)
Unilateral displaced subcondylar fracture with contralateral angle fracture (7 pt 23,33%)	4	3	Unilateral displacement (7 pt 23,33%)	Indirect (7 pt 23,33%)	OR and RF (7 pt 23,33%)	OR and RF (7 pt 23,33%)
Unilateral undisplaced subcondylar fracture with contralateral body fracture (8 patients (26,66%)	5	3	No displacement	Indirect (8 pt (26,66%)	OR and RF (2 pt 6,66%) & CR MMF (6 pt 20%)	CR and RF (5 pt (16.6%) OR and RF (3 pt 10%)
Unilateral undisplaced subcondylar fracture with contralateral angle fracture (5 pt (16,66%)	3	2	No displacement	Indirect (5 pt 16,66%)	OR and RF (2 pt 10%) & CR and MMF (3 pt 6,66%)	OR and RF (5 pt (16,66%)
Unilateral displaced subcondylar fracture (3 pt 10%)	2	1	Unilateral displacement (3 pt 10%)	Direct (3 pt 10%)	OR and RF (3 pt 10%)	
Undisplaced subcondylar fractures (2 patients (6,66%)	1	1	No displacement	Direct (2 pt(6,66%)	CR with MMF (2 pt 6,66%)	
			Dislocation (5 pt (16.6%); Displac-ement (10 pt 30%)	Indirect 25 pt (83.3%); Direct 5 pt (16.6%)	OR 18 pt (60%); CR 12 pt 40%)	OR 12pt (60%); CR 20pt 66,6%); No fracture

Table 2: Anamnestic index based on subjective findings (Helkimo 1974).

Fracture site	Ai0		AiI		AiII	
	M	F	M	F	M	F
Bilateral subcondylar fracture & symphysis with unilateral dislocation (3 patients)			2	-	-	1
Bilateral subcondylar fracture and symphysis fracture with bilateral dislocation (2 patients)	1	-	-	1	-	-
Unilateral displaced subcondylar fracture with contralateral angle fracture (7 patients)	3	1	1	2	-	-
Unilateral undisplaced subcondylar fracture with contralateral body fracture (8 patients)	3	1	2	-	-	2
Unilateral undisplaced subcondylar fracture with contralateral angle fracture (5 patients)	1	-	2	-	-	2
Displaced subcondylar fracture (3 patients)	-	-	1	1	1	-
Undisplaced subcondylar fractures (2 patients)	-	-	-	-	1	1
Total	8	2	8	4	2	6

Table 3: The clinical dysfunction index

Fracture	Di-0		Di-I		Di-II		Di-III	
	M	F	M	F	M	F	M	F
Bilateral subcondylar fracture & symphysis with unilateral dislocation (3 patients)	-	-	2	-	-	-	-	-
Bilateral subcondylar fracture and symphysis fracture with bilateral dislocation (2 patients)	1	-	-	1	-	-	-	-
Unilateral displaced subcondylar fracture with contralateral angle fracture (7 patients)	1	3	1	-	-	2	-	-
Unilateral undisplaced subcondylar fracture with contralateral body fracture (8 patients)	3	1	2	-	-	-	-	2
Unilateral undisplaced subcondylar fracture with contralateral angle fracture (5 patients)	1	-	-	-	2	2	-	-
Displaced subcondylar fracture (3 patients)	2	-	-	-	1	-	-	-
Undisplaced subcondylar fractures (2 patients)	-	-	-	-	-	-	2	-
Total	8	4	5	1	3	4	2	2
Percentage	26.6%	13.3%	16.6%	3.3%	10%	13.3%	6.66%	6.66%

Table 4: Direction of blow * Anamnestic index

			Anamnestic index			Total	*P*-value
			0Ai	AiI	AiII		
Direction of blow	Direct Trauma	N	0	2	3	5	0.105
		%	%0.	%40.0	%60.0	%100.0	
	Indirect Trauma	N	10	10	5	25	
		%	%40.0	%40.0	%20.0	%100.0	
Total		N	10	12	8	30	
		%	%33.3	%40.0	%26.7	%100.0	

Level of significance is 0.05 at the 5% level

Table 5: Direction of blow * Dysfunction index

			Dysfunction index				Total	*P*- value
			0-Di	I-Di	II-Di	III-Di		
Direction of blow	Direct Trauma	N	2	0	1	2	5	0.194
		%	%40.0	%0.	%20.0	%40.0	%100.0	
	Indirect Trauma	N	9	7	7	2	25	
		%	%36.0	%28.0	%28.0	%8.0	%100.0	
Total		N	11	7	8	4	30	
		%	%36.7	%23.3	%26.7	%13.3	%100.0	

Level of significance is 0.05 at the 5% level

Table 6: Direction of blow * Distribution of Injury

			Distribution of Injury				Total	*P*-value
			Bilateral Dislocation	Unilateral Dislocation	Unilateral Displacement	Undisplaced Fracture		
Direction of blow	Direct Trauma	N	0	0	3	2	5	0.494
		%	%0.	%0.	%60.0	%40.0	%100.0	
	Indirect Trauma	N	2	3	7	13	25	
		%	%8.0	%12.0	%28.0	%52.0	%100.0	
Total		N	2	3	10	15	30	
		%	%6.7	%10.0	%33.3	%50.0	%100.0	

Level of significance is 0.05 at the 5% level

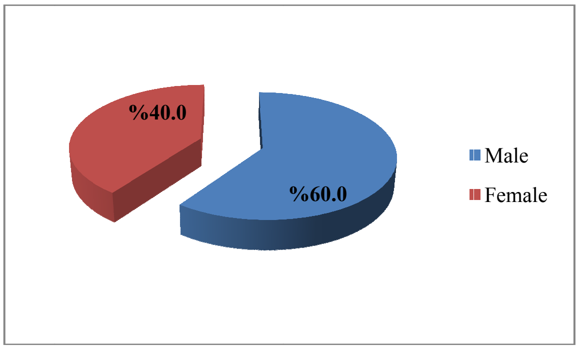

Fig. 1a: Distribution of male to female affections

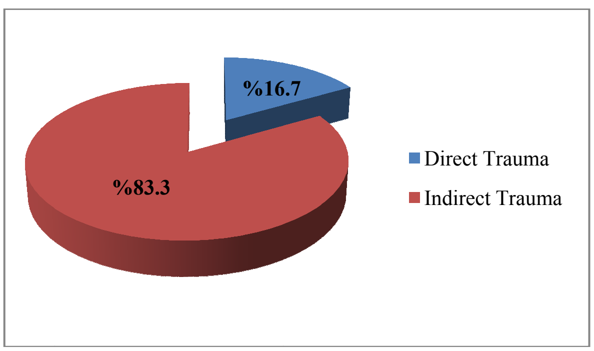

Fig. 1b: Distribution of direction of the blow

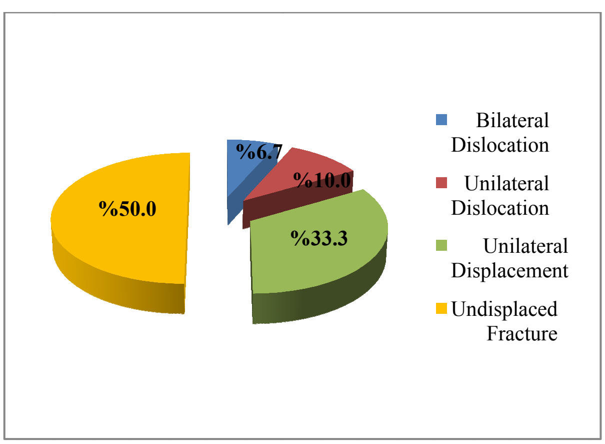

Fig. 1 c: Distribution of injury

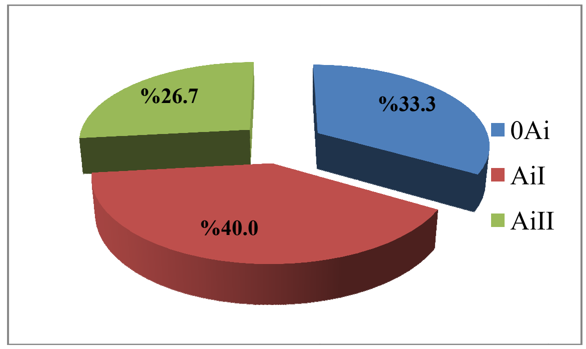

Fig. 1d: Distribution of amanestic index

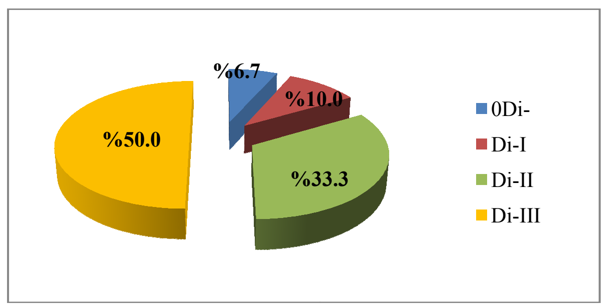

Fig. 1 e: Distribution of dysfunction index

Fig 2 a: Sagittal MRI reveals anterior displacement of the disc in the closed position with severe joint effusion.

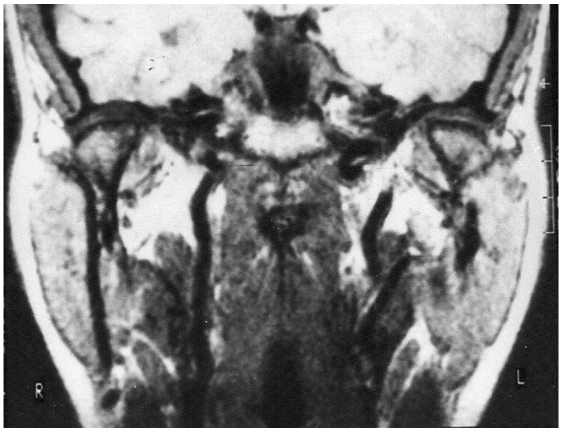

Fig 2 b: Coronal MRI reveals both condyles with no dislocation & minor damage.

Fig 3: Sagittal MRI reveals a left joint in the closed position showing condylar head dislocation, joint effusion & disc deformity.

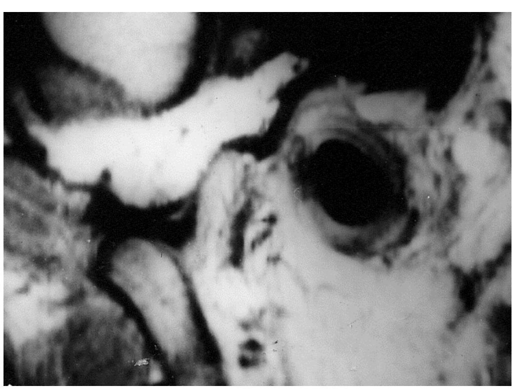

Fig. 4: Sagittal MRI of a joint in the open position revealing anterior disc displacement with disc damage.

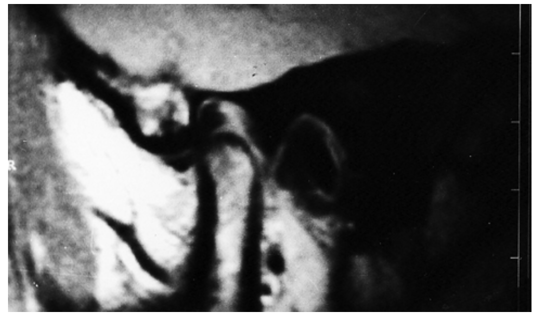

Fig. 5: Sagittal MRI of a joint in the open position revealing normal joint

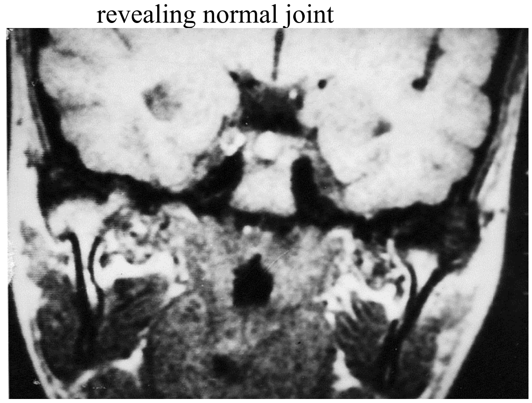

Fig. 6: Coronal MRI revealing osteophytes in the medial aspect of the right condyle & bilateral decrease signal intensity at the superior borders of both joints

4. Discussion:

TMJ is unique in that this joint dislocates itself within its ball and socket arrangement so the jaw can fully open. This intricate arrangement lends the TMJ susceptible to injury during traumatic episodes such as rear-end collisions involving cervical whiplash and other blows to the face[3].

In the present study, thirty patients with previously treated condylar and subcondylar fractures were examined for any TMJ disorder symptoms. The results proved that when the mandible is subject to trauma leading to fracture there is generally associated intra-articular injuries. This is supported by Luz *et al.,* [22] advocations, who studied the effect of indirect trauma to the rat temporomandibular joint (TMJ). The trauma, applied from an angle-glenoid fossa direction, produced injury of the TMJ. Their histological data demonstrated that the impact, both with or without fracture, caused proliferative changes in the TMJ. The glenoid fossa, the articular disk and the articular surface of the condyle were injured with thickening of the articular surfaces resulting in reduced joint space. Subsequently, remodeling changes in the condyle were found. Our findings conforms with Alastair and Arthur[9] suggestions who further emphasized that the side of the blow relates to the severity of the injury.

Males were more than females in a ratio of 3:2 as related to the traumatic etiology. However, females showed relative preponderance as regards the severity and frequency of TMJ post-traumatic persistent symptoms and dysfunctions as presented in (Tables 2 & 3). This in agreement with other author's[23-26] statement which advocated pain and dysfunction TMJ disorders seem to affect women more than men.

The present results showed that post-traumatic pathologic events can persist following treatment of mandibular fractures in the form of persistent symptoms pertinent to the TMJ joint mainly pain and varying degrees of dysfunctions. This is supported by several reports in the literature[18,19, 26]stating that traumatic events whether direct or indirect produce sudden displacement of the mandible leading to articular lesions. Our results could be attributed to Cascone's[27] interpretations that traumatic displacement of the mandible may result in damage or lesion to hard tissues, soft tissues or both. Soft tissue lesions can involve the ligaments, the disc or both. This agrees with our findings, where, 2 cases showed actual degenerative changes which could be correlated to Learetta's[26] interpretations that as a consequence of trauma the articular disc can suffer a displacement, a perforation or a burst. A further explanation could be attributed to that the ligaments responsible for disc repositioning can suffer distention and partial or total amputation as a consequence of trauma leading to secondary displacement of the disc.

The diagnosis of TMD in this work was based on history and clinical examination relying on subjective and functional indices, this agrees with McNeill's advocations[29] that the standard of care for TMD diagnosis is a thorough clinical examination performed according to a validated diagnostic scheme and reliable and repeatable techniques.

As regards MRI of the TMJ in the present work showed abnormal changes in cases which were correlated with their clinical and dysfunction indices, This agrees with Yengin and Evliyaolu[28] who considered MRI imaging when patients with pain are refractory to conservative therapy and if assessment of the hard and soft tissues via MRI will affect the diagnosis prognosis or treatment plan. Magnetic resonance signaling in the images helped to identify fluids associated with inflammation and effusion.

T2- weighted view were used in our study for abnormal fluid effusion through their hyperintensity signal, this has been adopted by Kirc[29] who reported that the earliest degenerative changes of the mandibular condyle could be detected with MRI. A hyperintensity signal in MRI is always shown in the T2-weighted view since this hyperintensity signal reflects the presence of fluid simply due to the density grading of the image. This agrees with Katzeberg *et al.,*[31] suggestions that post-treatment images in unsuccessfully treated patients detected the cause of residual pain whether caused by joint damage, or by masticatory muscle disorders. This held true in our study since out of the clinically symptomatic patients, 2 patients were detected on the MRI as having actual pronounced TMJ damage. The improving patients presented on the MRI as having joint effusion and inflammation as hyperintense areas in T2 weighted images and hypointense areas in T1 images.

Conclusion:

Impact and traumatic injuries can cause internal derangements of the temporomandibular joints associated with clinical and dysfunction symptoms. Persistent symptoms of TMJ dysfunctions after acute trauma to the mandible despite surgical re-alignment of fractures and their fixation could be attributed to inadequate primary evaluation of prognostic restitution of function.

Proper post-treatment evaluation of bony and soft tissue TMJ status following treatment of mandibular fractures exposed to direct or indirect trauma with or without condylar or subcondylar dislocation and/or displacement is mandatory to exclude any residual symptomatic or functional disability.

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