Assessment of the Inter-Molar Width Changes in the Mandible by using different Orthodontic Arch Wires: A Prospective Clinical Study

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Abstract— The demands for orthodontic treatment are in continuous increasing, hence producing an ideal treatment plan need to cover all stages of the treatment carefully, especially the retention and stabilization stage. As, any changing in the arch width through changing the inter-molar width will lead to impair the stabilization of the arch and will lead to relapse. Due to that, the present study performed to evaluate the inter-molar width of the mandible using three different commercial orthodontic wires. Thirty patients had been allocated in this study, using a cone beam computed tomography to create an assessment for the inter-molar width. It concluded that there is an increase in the inter-molar width between pre-treatment and after finishing of aligning stage, also there is a highly significant increase in post-aligning stage between the three groups.

Keywords— Inter-molar width changes, Orthodontic Arch Wires, retention stage, stabilization stage, NiTi wires.

I. INTRODUCTION

Creating a successful treatment depend on multiple factors, as these factors include obtaining a proper diagnosis, in addition to a good treatment plant which it includes both active and retention phases. Also, keeping the tooth in its position after treatment seems challenging in orthodontic field; hence multiple points of views and schools had displayed their solutions for that.[1-4]

During all of orthodontic treatment, the widths of both mandible and maxilla increase during the aligning phase with or without extractions. The higher changes took place in the area of premolars, then in the area of canines and, finally, in the area of molars, due to that, proper determining the arch form of the patient considered to be an essential parameter in creating a stable, functional and esthetic orthodontic treatment result, since failure to keep the arch form might raise the probability of relapse.[5-7]

In the market, there are multiple orthodontic wires, such Nickel–titanium (NiTi), stainless steel (SS), and beta-titanium wires. NiTi alloys are not rigid like SS or even beta-titanium. NiTi wires are so elastic that it is hard to create loops over them, and even after high deflections, they go back to their genuine shape when the force is removed, and the wires are unhanded.[8]

In the mid of 1990s another type of NiTi wires called Copper-nickel–titanium (CuNiTi) entered the market. By adding copper to the previous nickel–titanium alloy, thermal-activation became so easily controlled. They are marketed based on a different transition temperature: 27 degrees, 35 degrees, and 40 degrees. Therefore, the current study focused on the evaluation of the inter-molar width of the mandible by using three different commercial wires, to understand the effect of each wire on the arch width.[8,9]

II.   SUBJECTS AND METHODS:

Ethical consideration of this study had been obtained from the "Ethical committee in the faculty of medicine, Al-Azhar University in Egypt". This study performed on the patients that visited specialized orthodontic clinic, department of orthodontics, in the faculty of dentistry, Alazhar university. Thirty orthodontic patients including both genders had been joined into this study. By using a special randomization tool from this graphpad website. The patients allocated equally into three groups, as group A included ten samples treated with (beta-titanium) wire, group B included ten patients treated with (Copper Nickel titanium) wire, and group C included ten patients treated with (Nickel titanium) wire. Eligibility of the patients had selected according to the following inclusion criteria:

2.1   Inclusion criteria:

1. The age group of the patients was 14 to 20 years old.

2. Proper oral hygiene.

3. Patients with proper nutritional routine.

4. Medically free from any systematic or genetic diseases that may interfere with normal growth.

5. Absence of any growth abnormality and bone metabolic disorders.

6. The patient has full permanent dentition.

7. Patients who have mild to moderate crowding.

2.2   Exclusion criteria:

1. Patients who miss two successive appointments.

2. Patients who don't follow and apply researcher instructions.

2.3   Diagnosis and records:

According to the standard routinely procedures that's done in the clinic of orthodontic department, a record for the patient had been taken. The record contained:

1. Intra oral photography: Taken before, during, and after orthodontic treatment.

2. Extra oral photography: Taken before, during, and after orthodontic treatment.

3. Panorama: taken before and after orthodontic treatment.

4. Lateral cephalometric radiograph taken before and after orthodontic treatment.

5. A cone beam computed tomography (CBCT): Before treatment and after finishing the aligning stage.

2.4   Bonding and Loading wires:

The bonding procedures include the following steps[10]:

1. All the teeth cleaned, polished and prepared by using low speed handpiece and pumice free of fluoride.

2. Applying of acid etching on the labial and buccal surface of the teeth, using 37 % phosphoric acid (3M, Monrovia, California, United states of America). The application time was thirty seconds.

3. The etching gel then got washed, and then adhesive bond applied (Transbond XT, 3M, Monrovia, California, United states of America).

4. Curing technique used by applying a light cure (LED lamp (Opticore L3; MarslevByvej, Denmark). The application time is eighty seconds, as there is twenty seconds for every surface (mesial, distal, occlusal, gingival).

5. The excess composite then removed carefully using special instrument.

2.5   Wires loading:

Then the orthodontics wires prepared and loaded in the brackets according to table 1:

TABLE 1
THE LOADING OF WIRES AMONG GROUP.

Group A	Group B	Group C
Beta titanium wires (Ortho organizers inc, Carlsbad, CA) had been loaded	copper Nickel titanium wires (Henry Schein® Orthodontics)	Nickel titanium wires loaded (Ortho organizers inc, Carlsbad, CA)

III.   OBSERVATIONAL METHOD:

The observational methods used and depend on the superimposition that also applied via using CBCT, in a similar procedure and technique of this study.[10]

Each cone beam computed tomography scan was evaluated separately by inputting their DICOM files (Digital Imaging and Communication in Medicine) into a special software called Invivo anatomage version 5.2 (Anatomage Inc. San Jose, California) to obtain required measurements. To create standardization for the parameters, each scan was superimposed on its corresponding scan through using point registration so that evaluation can be done on the same cut for all the scans of the same patient, inter-canine width measurements done by using cups tips respectively. Then the same measurement was taken again at the same exact point (by transitioning to the superimposed post-operative scan (Figure-1), (Figure-2).
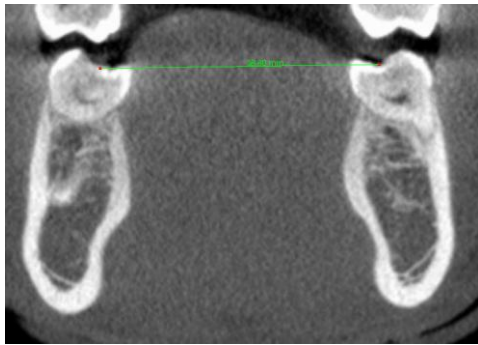
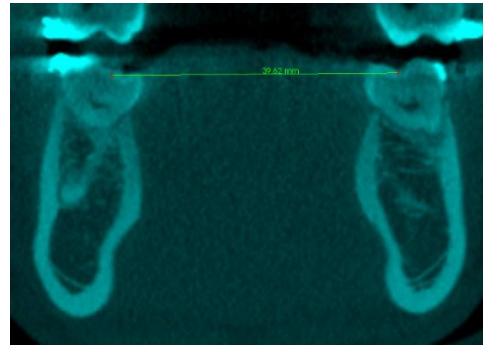**FIGURE 1: Pre operatively measured inter-molar width**

FIGURE 2: Post operatively measured inter-molar width

IV.   RESULTS:

4.1   Statistical Methodology

Data input, processing and analyzing of statistics was done via MedCalc ver. 18.2.1 (MedCalc, Ostend, Belgium). Data were displayed and proper analysis was done according to the type of data (parametric and non-parametric) obtained for each variable. P-values less than 0.05 (5%) was considered to be statistically significant.

P- value: level of significance

P > 0.05: Non-significant (NS).

P < 0.05: Significant (S).

P < 0.01: Highly significant (HS).

TABLE 2
SOCIO-DEMOGRAPHIC DATA AMONG 30 PATIENTS SEEKING ORTHODONTIC TREATMENT:

Variables		Frequency (%)
Age (years)		17.2 ± 1.76*
Gender	Females	19 (63.3%)
	Males	11 (36.7%)

* Mean ± SD.

TABLE 3
COMPARISON BETWEEN THE 3 GROUPS AS REGARDS SOCIO-DEMOGRAPHIC DATA USING ANOVA AND CHI SQUARE TESTS:

Variable		CNA group (10)	Cu NITI group (10)	NITI group (10)	ANOVA test
		Mean ± SD	Mean ± SD	Mean ± SD	P value
Age (years)		17.6 ± 1.6	16.8 ± 2.1	17.4 ± 1.5	= 0.588
Variable		CNA group (10)	Cu NITI group (10)	NITI group (10)	Chi square test
					P value
Gender	Female	6 (60%)	6 (60%)	7 (70%)	= 0.8663
	Male	4 (40%)	4 (40%)	3 (30%)	

ANOVA: analysis of variance. *Percentage of Column Total.

Comparative study between the 3 groups revealed non-significant difference as regards age and sex of the patients (p > 0.05).

4.2   Arch measurements & bone density data:

TABLE 4
MEAN OF INTER-MOLAR WIDTH OF THE 3 GROUPS AS REGARDS PRE-TREATMENT

Variable	Beta-Titanium (10)	Copper Nickel titanium (10)	Nickel titanium (10)
	Mean ± SD	Mean ± SD	Mean ± SD
IMW (mm)	40 ± 1.7	37.7 ± 1.37	39.98 ± 1.76

IMW: Inter Molar Width.

TABLE 5
COMPARISON BETWEEN THE 3 GROUPS AS REGARDS POST-ALIGNING STAGE DATA USING ANOVA TEST

Variable	Beta-Titanium (10)	Copper Nickel titanium (10)	Nickel titanium (10)	ANOVA test
	Mean ± SD	Mean ± SD	Mean ± SD	P value
IMW (mm)	40.34 ± 1.5	38.1 ± 1	40.5 ± 1.48	= 0.001**

IMW: Inter Molar Width.

Comparative study between the 3 groups revealed; highly significant increase in post-aligning IMW in CNA and NITI groups; compared to Cu NITI group; with highly significant statistical difference ($p < 0.01$ respectively).

4.3   Factorial ANOVA table and multi-variate graphs revealed that:

We found marked increase in IMW in Cu CNA and NITI groups; compared to CNA group; during the serial pre and post-aligning measurements.
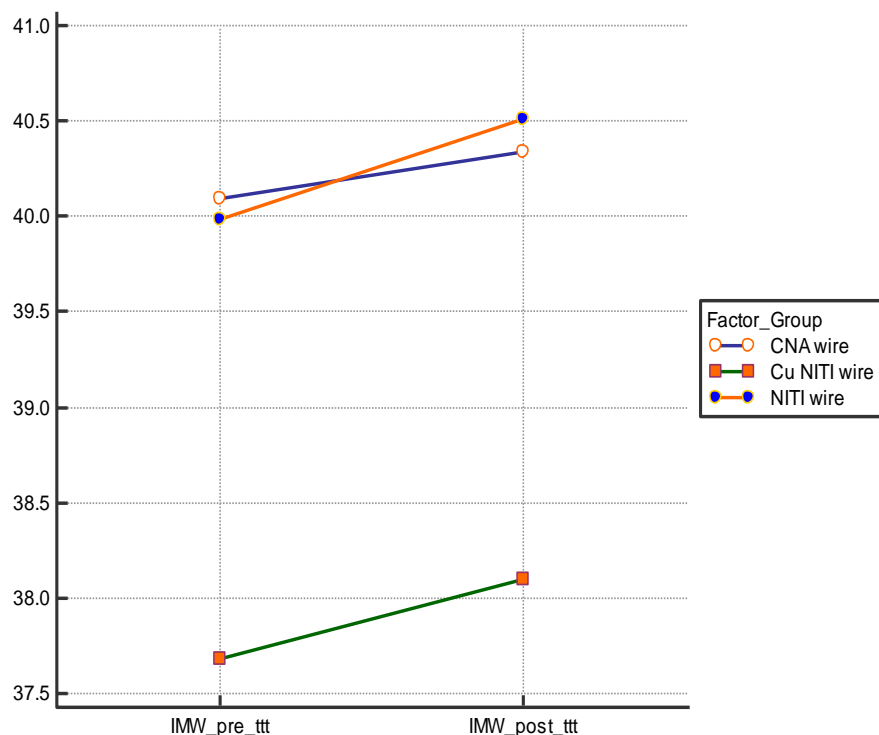

FIGURE 3: Comparison between the 3 groups of patients regarding serial IMW assessments.

TABLE 6
IMPACT OF GENDER ON POST-TREATMENT EFFICACY OF EACH WIRE USING STUDENT'S t TEST:

Variable	Females (Beta-Titanium) (6)	Males (Beta-Titanium) (4)	Student's t test
	Mean ± SD	Mean ± SD	P value
IMW	40.5 ± 1.47	40 ± 1.72	= 0.647
Variable	Females (Copper Nickel titanium) (6)	Males (Copper Nickel titanium) (4)	Student's t test
	Mean ± SD	Mean ± SD	P value
IMW	38.46 ± 1.08	37.5 ± 0.96	= 0.211
Variable	Females (Nickel titanium) (7)	Males (Nickel titanium) (3)	Student's t test
	Mean ± SD	Mean ± SD	P value
IMW	40.2 ± 1.67	41.13 ± 0.83	= 0.417

Regarding CNA group: Gender had non-significant effect on IMW, in CNA group (p > 0.05 respectively).

Regarding Cu NITI group: Gender had non-significant effect on IMW in Cu NITI group (p > 0.05 respectively).

Regarding NITI group: Gender had non-significant effect on IMW, in NITI group (p > 0.05 respectively).

V.   DISCUSSION

The causes of the high increase in demanding for orthodontics treatments is not coming back for the aesthetic purpose only, but it includes other multiple reasons, such as improvement and development in the social and economic status of the patients. Well, this opened a new challenge to understand the stability of the dental arches, since any changes in the arch dimension, will lead to a relapse post-orthodontic treatment.[11]

Consequently, in this study it focused to understand the effect that it may happen on the inter-molar width of the mandible by using different orthodontic arch wires. There are multiple orthodontic arch wires in the markets, hence it focused to evaluate the influence of these wires during the aligning stage and compare that effect between them. The present study included thirty patients, which is divided into three groups, as every group contained ten patients using certain wires. In this study we used a CBCT as an observational method, since this is showed that measurements of distance between anatomical land marks using CBCT software packages revealed superior accuracy when compared with distances measured with a digital caliper.[12]

The results of the present study showed that a clear increase in the inter-molar width between the three groups, also the gender seems to have no influence in the inter-molar width after finishing of the aligning stage. However, the previous tables from results showed that there is increase in the inter-molar width between pre-treatment and after the finishing of aligning stage.

The retention in orthodontic treatment considered to be the last stage, which this stage aims to preserve the teeth in their corrected positions after the completion of orthodontic tooth

movement, since the change in inter-premolar width may influence the rate of stability, hence, the present study focused on evaluating the inter-premolar width in the mandible after the levelling and aligning stage, which is a major stage in orthodontic treatment.[13]

Germec-Cakan et al. performed a study on arch-perimeter changes in patients with Class I malocclusion that go under orthodontic treatment using both extractions or non-extractions approaches, they found that the maxillary and mandibular inter-molar widths decreased in the extraction group, however in the non-extraction group, the inter-molar widths minimized but arch perimeters did not change significantly. Well these results come in disagreement with our results, as in the present the study it found that the inter-molar width has increased despite that the patients went in non-extraction approach as a line of treatment. These differences may come back to difference in the study design and methodology between the two studies.[14]

Kim and Gianelly, creates a comparison of the changes of arch-width and smile esthetics in thirty non-extraction and thirty patients with extraction approach. They found that inter-molar width reduced in both mandibular and maxillary arch in the extraction group and increased in the non-extraction group. According to non-extraction group, their findings come in agreement with the results in the present study.[15]

Unfortunately, there is not much articles that focused on the comparison between those wires, however, multiple studies have focused on evaluation the changes that it may happen in the arch dimension, but it's difficult to create a comparison between the present study and those studies, due the major differences in the study design, methodology, and observational methods. Consequently, it recommended obtaining further investigations in this sector.[16-18]

VI. CONCLUSION:

The present study concluded that there is an increase in the inter-molar width between pre-treatment and after finishing of aligning stage, also there is a highly significant increase in post-aligning stage between the three groups.

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