Arch Dimensions Changes of Egyptian Orthodontic Patients using Different Orthodontic Archwires: A Prospective Clinical Study

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Abstract—

Objective: The aim of the present study was to make an evaluation of inter-canine width before and after the stage of levelling and alignment in the mandible using three different orthodontic arch wires.

Subjects and methods: Thirty orthodontic patients both males and females were selected and treated by the same researcher. The patients were randomly divided equally into three groups according to the type of wire that was used, so Group A, B and C will be used. Group A, this group included 10 patients treated with (CNA) wire. Group B, this group included 10 patients treated with (Cu NITI) wire. Group C, this group included 10 patients treated with (NITI) wire.

Results: The results showed that inter-canine width showed no significance after the finishing of the leveling and alignment stage.

Keywords: arch, wires, inter-canine, width, orthodontic.

I. INTRODUCTION

Dentofacial aesthetics considered to be the major motivational concern in both adolescent and adult population to go under orthodontic treatment. The number of those patients that conduct orthodontic therapy showed a constant rising over last 2-3 decades. Studies showed that orthodontic treatment produce a proper dental aesthetics also has a great effect on the psychosocial dimension of the patient's life. It has been showed that almost 80% of orthodontic patients accept treatment because of the aesthetic aspect rather than dental health and function.[1]

The most essential part inside the orthodontic treatment is providing a proper aligning for the teeth on the patient's dental arches. Every patient has a unique arch form and arch size. Stability of orthodontic treatment depends on keeping the patient's pre-treatment arch form and arch size during and at the end of treatment.[2]

Multiple years ago, a high attention was applied to the arch form; the Bonwell-Hawley pattern identified by Chuck GC was one of the traditional ideal arch forms that used to create arch wires. Nowadays, multiples diagrams were created through using different mathematical formula to obtain arch wires that are similar in size and form to normal dental arches and to help the orthodontists during treatment.[3]

Dental arches have a variation among races and populations. Hence, the arch wires should be chosen according to the related population's arch's shape and size. In a study of American patients by Braun *et al.*, thirty-three preformed nickel-titanium wires were compared with normal dental arches. They found that the inter-canine and inter-molar widths of upper and lower preformed arch wires were greater than

the average dental arch widths in almost their entire sample. Similar results were achieved by another study conducted in India.[2,4]

Introducing nickel-titanium (NiTi) alloys has create a revolution in the world of orthodontic wires and convert the dream of applying continuous and constant forces into reality. Multiple Enhancements were applied in producing austenite active (super-elastic) and martensite active (heat-activated) NiTi wires to benefit from the extraordinary super-elasticity and shape memory properties of NiTi alloys. NiTi wires with copper (CuNiTi) grew commercially in the mid 90's and were produced in three transition temperatures, one of which was super-elastic (CuNiTi 27ºC) and two heat activated (CuNiTi 35ºC and CuNiTi 40ºC). As it mentioned this type of wires contain copper, which is efficient heat conductor, due to that those wires displayed a proper defined transition temperature.[5]

In spite of the availability of different brands of arch wires in Egypt, only a few of them can be used safely to avert post treatment relapse. From that concept this study focused on evaluation of the inter-canine width of the mandible using copper-niti orthodontic arch wire.

II.   SUBJECTS AND METHODS:

The present study is randomized clinical study. The unit of analysis and randomization is the individual patient. This study was conducted on patients seeking orthodontic treatment in the outpatient clinic, Faculties of Dental Medicine, Al-Azhar University, Cairo, Boys and girls Branches. Thirty orthodontic patients both males and females were selected and treated by the researcher. The patients were randomly divided equally into three groups according to the type of wire that was used, as group A included 10 patients treated with (CNA) wire, group B included 10 patients treated with (Cu NITI) wire, and group C included 10 patients treated with 10 patients treated with (NITI) wire.

2.1   Eligible patients will be selected according to the following inclusion and exclusion criteria:

2.1.1   Inclusion criteria:

- ➢ The patient age is ranged from 14 to 20 years.
- ➢ Good oral and general health with absence of any nutritional problems.
- ➢ No systemic diseases or chronic illness that might affect normal growth.
- ➢ Absence of any growth abnormality and bone metabolic disorders.
- ➢ The patient should have a permanent dentition.
- ➢ The patient should have not any type of abnormality or disease that may affect the bone.
- ➢ The patients should have no systemic or genetic disease that could interfere with orthodontic treatment.
- ➢ The patients should have minimal to moderate crowding.

2.1.2   Exclusion criteria:

- ➢ Patients with retained deciduous teeth.
- ➢ Uncooperative patients who miss two successive appointments.
- ➢ Uncooperative patients who do not follow the operator's instructions.
- ➢ Patients who will need extraction one or group of teeth as a part of orthodontic treatment.

As part of the procedure for treatment of patients in the outpatient clinic of the Orthodontic Department, standard records will be taken including orthodontic study models, intra and extra oral photography, panorama, and lateral cephalometric radiographs. The records were taken before and after the treatment except the intra and extra oral photographs, they were taken before, during and after the treatment. A CBCT of the mandible will be taken before orthodontic treatment and after completing the aligning of the teeth of the lower arch.

All teeth were cleaned with water and fluoride-free pumice for at least 30 seconds and then dried with an oil-free air syringe. The enamel was then etched for 30 seconds with 37% orthophosphoric acid **(etching gel, 3M, Monrovia, CA, USA)**, and the Primer **(Transbond XT, 3M, Monrovia, CA, USA)** was applied with a small brush and spread with oil-free compressed air (figure.1). The composite **(Transbond XT, 3M, Monrovia, CA, USA)** was applied on the bracket base, and the attachment was positioned on the tooth surface. Composite excess was removed by using a probe before polymerization. The composite was polymerized with a LED lamp **(Opticore L3; MarslevByvej, Denmark)** for 80s per bracket (20 s for every side: mesial, distal, occlusal and gingival). Then the wires (figure.2) get loaded and ligated using elastic ligatures. In group A, CAN wires**(Ortho organizers inc, Carlsbad, CA)** had been loaded, in group B copper niti wires **(Henry Schein® Orthodontics)** had been loaded, and in group C niti wires loaded **(Ortho organizers inc, Carlsbad, CA)**. The sequences of wires that it's loaded those sizes had used 0.014", 0.016", 0.018" and 0.016*0.022".

**FIGURE 1: Composite, primer and bracket used.**

FIGURE 2: NiTi, CNA, Cu-NiTi wires.

In the present study it was designed to evaluate inter-canine width of the mandible. Consequently, the patient had two CBCT on the mandible, the first one was pre-orthodontic treatment and the second one was after completing the stage leveling and aligning of the teeth. The scans were obtained from I-Cat scanner (Imaging Sciences, Hatfield, PA, USA) under fixed parameters (120 KVP, 37 mA, and 0.25 μm in 26.9 seconds) with amorphous silicon flat panel detector. Field of View (FOV) was adjusted separately for each human mandible according to its size and dimension.

Each CBCT scan was assessed separately by inserting their DICOM files (Digital Imaging and Communication in Medicine) into Invivo dental software version 5.2 (Anatomage Inc., San Jose, CA) to perform the study measurements. To standardize the measurements, each scan was superimposed on its corresponding scan by point registration so that assessment 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 (figure.3) by transitioning to the superimposed post-operative scan.

FIGURE 3: Pre and post measured inter-canine width.
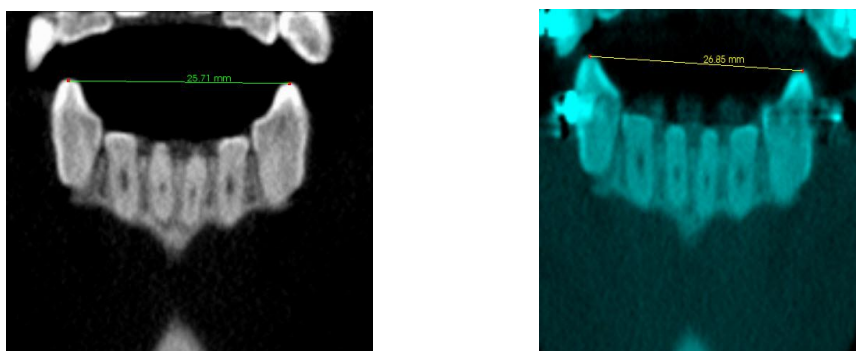
2.2 Ethical considerations

Ethical consideration had been taken from the Ethical committee in the faculty of medicine, Al-Azhar University in Egypt.

III. RESULTS

TABLE 1

SOCIO-DEMOGRAPHIC DATA AMONG 30 PATIENTS SEEKING ORTHODONTIC TREATMENT

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

* Mean ± SD.

TABLE 2

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.

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

TABLE 3
COMPARISON BETWEEN THE 3 GROUPS AS REGARDS PRE-TREATMENT DATA USING ANOVA TEST.

Variable	CNA group (10)	Cu NITI group (10)	NITI group (10)	ANOVA test
	Mean ± SD	Mean ± SD	Mean ± SD	P value
ICW (mm)	26.57 ± 1.4	26.2 ± 1.6	27.4 ± 2.2	= 0.313

ICW: Inter Canine Width, ANOVA: analysis of variance.

Comparative study between the 3 groups revealed non-significant difference as regards pre-treatment ICW ($p > 0.05$).

TABLE 4
COMPARISON BETWEEN THE 3 GROUPS AS REGARDS POST-ALIGNING STAGE DATA USING ANOVA TEST.

Variable	CNA group (10)	Cu NITI group (10)	NITI group (10)	ANOVA test
	Mean ± SD	Mean ± SD	Mean ± SD	P value
ICW (mm)	28 ± 1.86	27.7 ± 1	28.45 ± 1.7	= 0.598

ICW: Inter Canine Width, ANOVA: analysis of variance.

Comparative study between the 3 groups revealed non-significant difference as regards post-aligning stage ICW ($p > 0.05$).

We further analyzed and compared all 30 (paired) patients according to the serial (ICU) (pre and post-aligning stage); with entering a grouping factor **(CNA, Cu NITI or NITI)**; data are shown in the following tables & figures:

TABLE 5
COMPARISON BETWEEN THE 3 GROUPS OF PATIENTS AS REGARDS ARCH INTER-CANINE WIDTH USING REPEATED MEASURES ANOVA TEST (3-FACTOR STUDY):

Variables	Repeated 2 measures ANOVA (2-F: between the 2 groups)	
	F ratio	P value
ICW (mm)	0.99	0.386

ANOVA: analysis of variance, 3-F: 3-factor study. #logarithmic transformation was done to non-parametric data.

We found increase in ICW in all the 3 groups; with non-significant difference between them; during the serial pre- and post-aligning stage measurements.
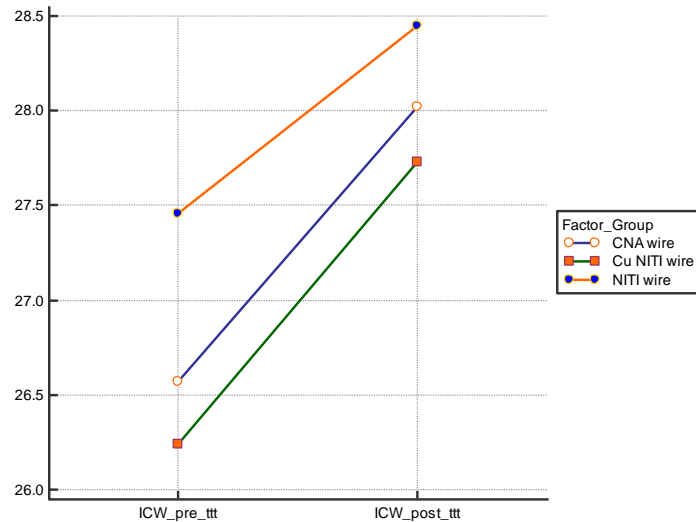
FIGURE 4: Comparison between the 3 groups of patients regarding serial ICW assessments.

TABLE 6
IMPACT OF GENDER ON POST-ALIGNING STAGE EFFICACY OF EACH WIRE USING STUDENT'S T TEST.

Variable	Females (CNA group) (6)	Males (CNA group) (4)	Student's t test
	Mean ± SD	Mean ± SD	P value
ICW	27.9 ± 1.12	28.1 ± 2.88	= 0.869
Variable	Females (Cu NITI group) (6)	Males (Cu NITI group) (4)	Student's t test
	Mean ± SD	Mean ± SD	P value
ICW	27.6 ± 0.9	27.85 ± 1.39	= 0.790
Variable	Females (NITI group) (7)	Males (NITI group) (3)	Student's t test
	Mean ± SD	Mean ± SD	P value
ICW	28.6 ± 1.9	27.9 ± 1.09	= 0.587

Regarding the entire group, gender had non-significant effect on the inter-canine width.

IV.   DISCUSSION

The present study focused in evaluating the changes that it happened in the inter-canine width before starting the orthodontic treatment and after finishing the leveling and aligning stage. The rate of success of orthodontic treatment of malocclusions depends on accurate diagnosis and the formulation of a treatment plan that involve both the active and retentive phase of treatment, hence, preserving the position of the teeth of the orthodontic patient that attained by treatment appears to be the most complicated task of the orthodontic profession. Consequently, many theories and schools of thought have been proposed with regard to treatment goals, objectives and limitations.[7]

The main focus of the present study is the evaluation of the inter-canine width of the mandible, which it will influence the rate of the stability of the mandibular arch. Multiple factors though to play an important part in the influencing the changes that it may happen in the inter-canine width, such as using different orthodontic arch wire, presence of cleft palate, and the treatment plan if it will include extraction or non-extraction approach. Consequently, it difficult to obtain a direct comparison between the findings of this study and other study that focused on evaluation the stability of the arches by assessing the inter-canine width.

The results of the present study showed that there is no significance between the inter-canine width in the three groups before and after the leveling and aligning stage. Also, the gender showed a non-significant effect on the inter-canine width in the mandible. Those findings may come back to the rapprochement of the arch form of the mandible between the Egyptian and European population.

The mean of the inter-canine width in three groups showed an increase, for example the mean of CNA group was (26.57 ± 1.4) before starting the treatment, then it changed to be (28 ± 1.86) in the end of the leveling and alignment stage. Despite that there is a real increase but it's non-significant. Also The impact of gender seems to have no impact on the findings of this study; this also may come back to the close rapprochement and similarity between the shape, form, and width of the mandible of Egyptian population and other populations from different nations.

Motamedi AK et al[7], conduct a study to determine the pattern and amount of change exhibited in mandibular inter-canine and intermolar width during treatment and assessing its stability1-3 years post-retention, the study included three groups (extraction, non-extraction, and control group). They found in contrast to both treated groups, inter-canine width of the control group predominantly decreased between 12 and 15 years of age and either continued to decrease or were maintained between 15 and 18 years of age. The loss in mean inter-canine width during the first phase was 0.22 mm and 0.28 mm in the second phase, whereas a mean total loss of 0.5 mm. When comparing the control group with the treated groups, it is interesting to note that, unlike the control group, the mean inter-caninne width of the non-extraction group increased 1.18 mm during treatment. Also, this come in disagreement with the results of this study, this disagreement may come back to multiple differences in the study design and in observation methods, as the present study used a cbct.

Aiyesha Wahaj et al.[8] performed a study to evaluate the difference of arch dimensions through inter-canine and intermolar between patient with cleft lip palate and normal class I occlusion patient group. They found that in mandibular arch, only inter-canine width has showed significant difference between cleft and normal occlusion class I group. These finding come in disagreement with the findings of the present study, this disagreement may come back to multiple factors like methodological and study design differences. As the present study considered being a prospective clinical study while that study considered to be a cross-sectional analytic study.

AA Oz et al.[9] performed a study to compare the arch width changes in patients treated fixed orthodontic mechanics without extraction (Group 1), with upper and lower first premolar extractions (Group 2), and with upper first premolar extraction only (Group 3). They found that Anterior, middle, and posterior arch widths increased significantly in Groups 1 and 3. Maxillary anterior and middle arch widths also increased in Group 2, but the increases were not statistically significant. These findings come in agreement with the results of the present study.

Declan et al.[10] found in his study that orthodontic management provide an increase in the maxillary canine and a decrease in the mandibular canine widths, as these findings come in disagreement with the results of our study, since the present study found that there is an increase in the inter-canine width after leveling and aligning stage but it's not significant. This disagreement may come to some difference in methodological criteria and study design. However, Declan showed that Sex had no significant influence on the results of the study.

The present study didn't take a focus on the extraction cases, as the main focus on non-extraction cases. For years, the use of extraction therapy in orthodontic treatment of malocclusions has been discussed with both the pro- and anti-extraction groups arguing the case for their treatment plans. Some authors such as Bishara et al. have concluded that extraction groups and non-extraction groups show similar overall trends in some width parameters (inter-canine) and different trends in other parameters (intermolar). Bishara et al. went on to conclude that the extraction/nonextraction decision on the basis of good diagnostic criteria does not have a detrimental effect on the facial profile.[10-12]

Lee[13] stated that extraction will minimize arch width and the inclusion of teeth, eg, by orthodontic inclusion of a previously excluded tooth, will increase arch length and leads to a potential increase in arch width. More recently, in 2003, Gianelly[14] reported mandibular inter-canine dimension to be 0.94 mm larger in the extraction sample than the non-extraction sample. In this study, the results of the analysis adjusting for extraction were inconclusive and require further study. Consequently, for more reliable results we focused the present study on non-extraction cases.

V. CONCLUSION

There is no significant change between the inter-canine width before and after the stage of leveling and alignment. Also, the gender has no significant effect in the changes of the inter-canine width before and after leveling and aligning stage.

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