

Evaluation of the Inter-Premolar Width Changes in the Mandible using Three Different Commercial Arch Wires: A Prospective Clinical Study

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Abstract—

Objective: The aims of this study isto evaluate the inter-premolar width changes in the mandible using three different commercial orthodontic arch wires.

Subjects and methods: Thirty patients including both males and females have been allocated in this study. Three orthodontic wires including NiTi, copper NiTi, and Beta-Titanium wires had been used. A special observational technique including cbct had been used to make an evaluation for the inter-premolar width before and after the aligning stage.

Results: The results showed a highly significant increase in post-treatment inter premolar width in CNA and NITI groups; compared to Cu NITI group; with highly significant statistical difference ($p < 0.01$ respectively).

Conclusion: The present study showed that there is a high significant increase in the inter-premolar width in the mandible, when comparing the wires in the groups (NiTi, CNA, and copper niti). Also, the gender of the patient does not seem to have an impact of the gender on post-treatment efficacy of each wire.

Keywords— Mandible, Commercial Arch Wires, NiTi, copper NiTi, Beta-Titanium wires.

I. INTRODUCTION

One of the targets of orthodontic treatment is to provide improvement in the dental health; this is also obtained through positioning the teeth into the best functional balance using fixed appliances. Consequently, an increasing in the number of adult patients who seeking orthodontic treatment is shown, not only for aesthetic purposes, but also due to recent development in socioeconomic conditions.^{1,2}

Researchers have attempted to define and direct appropriate dental arch forms. With the coming of the pre-adjusted straight wire appliance, trials have been made to create a design and start commercializing arch-wires with ideal arch form.³

Tabulation of arch forms has implicated various geometric and complex mathematical formulas. The changes that it may happen in the form of the dental arch have suggested showing an effect on the stability and the periodontium. To decrease the chances of treatment relapse, multiple methods have been suggested, including preservation of the mandibular incisors in their pre-treatment position and preservation of the original arch form.^{3,4}

At first, the form of the arch is shaped by the configuration of the supporting bone, then the eruption of teeth, it is further adjusted by the surrounding musculature and functional forces. If this arch form is changed during orthodontic treatment, there will be tendency to get back to its pre-treatment shape. Multiple studies have mentioned the return of the canine and molar widths to pre-treatment position during the post-retention phase if the original arch form is altered. Consequently, the preservation of original arch form rather than arch modification is generally recommended to reduce the relapse tendency.⁵

Nickel-titanium (NiTi) arch wires are commonly used in the initial aligning stage of orthodontic treatment, as these wires own greater elasticity and resilience with low elastic modulus and rigidity. As from the presentation of NiTi arch wires into field of orthodontics, multiple elements have been added in order to obtain clinical benefits, copper considered to be one of these elements that have been added to NiTi, which is give a lowering in the loading stress while displaying relatively high unloading stress, which can result in more effective orthodontic tooth movement.⁶ In the mid of the 90s, the copper NiTi wires rushed the market, and were distributed with three transition temperature, the first type is the superelastic (27°C), the other two types are the heat activated (35°C and 40°C), also the presence of the copper give the wire a better defined transition temperature, which increase the efficiency of tooth movement.⁷

In 1979, new wire presented to orthodontic field, these wires called Beta-titanium (β -Ti) alloy wires; these wires achieved a great publicity, due its biocompatibility, resistance to corrosion, and low stiffness. Despite the fact that there are multiple and 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-premolar width of the mandible using three different orthodontic wires.⁸

II. SUBJECTS AND METHODS

Ethical consideration had been taken from the Ethical committee in the faculty of medicine, Al-Azhar University in Egypt. This study conducted on the patients that visited specialized orthodontic clinic, 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 website: <https://www.graphpad.com>, the patients divided into three groups through randomization. The patients allocated equally into three groups, as group A included ten samples 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. Eligibility of the patients had selected according to the following inclusion and exclusion criteria

2.1 Inclusion criteria:

1. The age of the patients ranging from 14 to 20 years old.
2. Proper oral hygiene with adequate nutritional routine.
3. Medically free from any systematic or genetic diseases that may interfere with normal growth.

4. Absence of any growth abnormality and bone metabolic disorders.
5. The patient has full permanent dentition.
6. Patients who have mild to moderate crowding.

2.2 Exclusion criteria:

1. Patients who have retention in the deciduous teeth.
2. Patients who don't attend more than two successive appointments.
3. Patients who don't follow the researcher's instructions.
4. Patients who will need extraction one or group of teeth as a part of orthodontic treatment.

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.
2. Extra oral photography.
3. Panorama.
4. Lateral cephalometric radiograph.

All of that records done before and after orthodontic treatment, except for the photographs, as it done additionally during orthodontic treatment. A cone beam computed tomography for the mandible had been done before beginning of orthodontic treatment and after the finishing of aligning stage.

2.4 B- Bonding Procedure

The bonding technique was done in a similar method to this study⁹:

1. The teeth were cleaned and dried to be prepared for the next step in bonding procedures.
2. The etching applied on the enamel for 30 seconds using 37% phosphoric acid (etching gel, 3M, Monrovia, CA, USA).
3. The bonding agent (Transbond XT, 3M, Monrovia, CA, USA) was applied on the tooth.
4. The composite (Transbond XT, 3M, Monrovia, CA, USA) was applied on the bracket base. The composite was polymerized by using LED lamp (Opticore L3; MarslevByvej, Denmark)

2.5 Wires loading

Then the orthodontics wires prepared and loaded in the brackets:

TABLE 1
THE LOADING OF WIRES AMONG GROUP

Group A	Group B	Group C
CNA wires (Ortho organizers inc, Carlsbad, CA) had been loaded	copper NiTi wires (Henry Schein® Orthodontics)	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".

2.6 Observational method

According to this study⁹, same observation method had been used. As, the present study used cone beam computed tomography to create an evaluation.

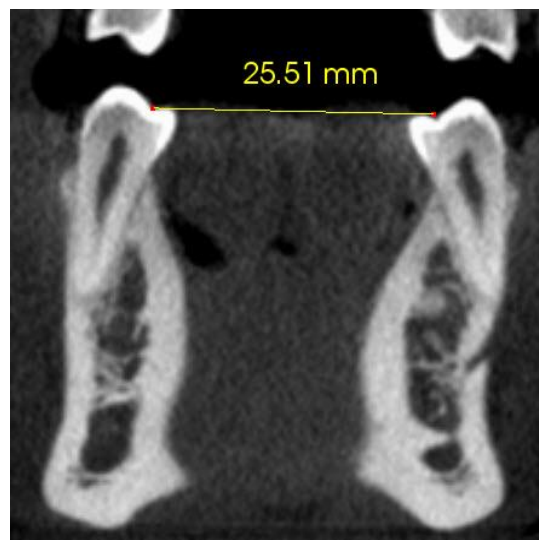


FIGURE 1: Measuring the inter-premolar width

III. RESULTS

TABLE 2
MEAN OF INTER-PREMOLAR WIDTH IN THE 3 GROUPS.

Variable	CNA group (10)	Cu NITI group (10)	NITI group (10)
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
IPW0(mm)	34.7 $\pm$ 2	31 $\pm$ 2.99	33.68 $\pm$ 1.98

IPW0: Inter Premolar width before treatment.

TABLE 3
SOCIO-DEMOGRAPHIC DATA AMONG 30 PATIENTS SEEKING ORTHODONTIC TREATMENT:

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

** Mean $\pm$ SD.*

This table shows that; the mean age of all patients was (17.2 $\pm$ 1.76) years. Regarding gender of the patients, the majority (63.3%) of patients were females; while (36.7%) were males.

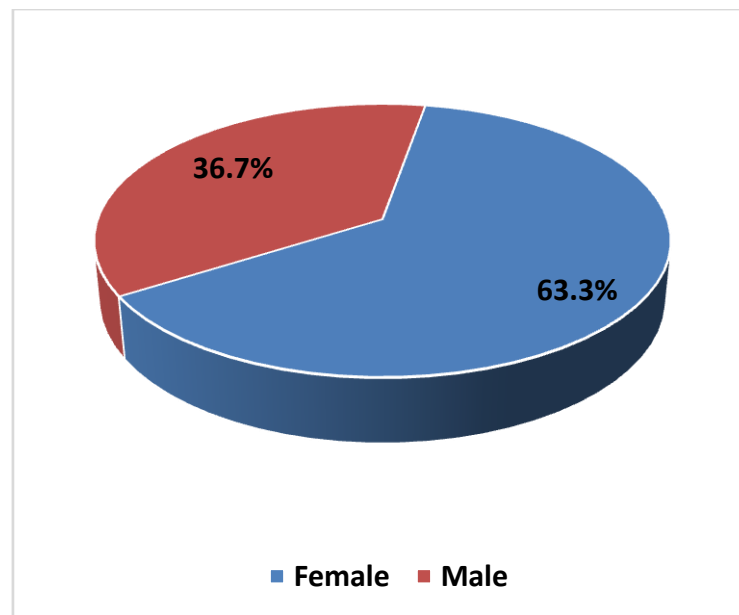


FIGURE 2: Gender among 30 patients seeking orthodontic treatment

TABLE 4

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 $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	P value
Age (years)		17.6 $\pm$ 1.6	16.8 $\pm$ 2.1	17.4 $\pm$ 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 ($p > 0.05$).

TABLE 5

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 $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	P value
IPW0-IPW6(mm)		37.3 $\pm$ 1.1	34.3 $\pm$ 2	35.7 $\pm$ 2.1	= 0.004**

IPW0: Inter-premolar width before treatment, IPW6: Inter-premolar width after aligning stage

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

3.1 Impact of gender on post-treatment efficacy of each wire:

TABLE 5
IMPACT OF GENDER ON POST-TREATMENT EFFICACY OF EACH WIRE USING STUDENT'S T TEST:

Variable	Females (CNA group) (6)	Males (CNA group) (4)	Student's t test
	Mean $\pm$ SD	Mean $\pm$ SD	P value
IPW6	37.48 $\pm$ 0.97	37.1 $\pm$ 1.44	= 0.626
Variable	Females (Cu NITI group) (6)	Males (Cu NITI group) (4)	Student's t test
	Mean $\pm$ SD	Mean $\pm$ SD	P value
IPW6	34.4 $\pm$ 2.4	34 $\pm$ 1.67	= 0.746
Variable	Females (NITI group) (7)	Males (NITI group) (3)	Student's t test
	Mean $\pm$ SD	Mean $\pm$ SD	P value
IPW6	35.3 $\pm$ 2.44	36.6 $\pm$ 0.9	= 0.399

IPW6: Inter-premolar width after aligning stage

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

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

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

IV. DISCUSSION

The increasing in demands for orthodontic treatment by adult patients is not focusing only on aesthetic purposes, but also due to recent improvements and development in socioeconomic conditions. This new perspective increased the demands to investigate both skeletal and dental changes in soft tissue morphology of adult individuals, considering the increasing search for orthodontic and orthognathic treatment. Understanding these changes may help to know if that notified changes took place primarily due to orthodontic relapse or are part of the natural process of development and maturation.¹⁰⁻¹²

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

Devinder Preet et al.¹⁴ performed a study in 2014 to create an evaluation in the pre-treatment and post-treatment arch parameters in both upper and lower arches in orthodontic patients that had their treatment using extraction of first premolar teeth. They found that the overall arch width changes within the Classes I and II were also significant except inter-premolar arch width changes in the maxillary arch both in Class I and Class II div 1 subjects and the inter-incisal arch width changes in Class I subjects in the mandibular arch. Which it shows that there is a significant change in the inter-premolar in the mandible in both class I and class II

cases? Well, this come in agreement with the findings of the present study, despite that there are multiple differences in the methodology and study design.

In assessing the stability of the mandibular arch following orthodontic treatment, Gardner and Chaconas, examined the clinical records of 74 non extraction and 29 extraction patients. They found that the inter-second premolar width increases during treatment. Also, the findings that co-related to non-extraction cases come in agreement with findings if the present study.^{14,15}

Eunkoo Kim performed a study in 2003 to evaluate both arch widths and smile esthetics. Their findings included that there is decrease in widths in both arches in the extraction sample, whereas this dimension increased in the non-extraction subjects. The results that's come in relation to extraction samples come in disagreement with the results of the present study, as the present study showed that there is an increase in the inter-premolar width, these disagreement may be because that the samples included extraction cases while the samples of the present study focused on non-extraction cases. However, the findings of Eunkoo Kim et al. that's related to non-extraction cases come in agreement with the findings of present study, as they showed that the inter-premolar width had increased. Long-term studies assessed the postoperative changes of orthodontically treated cases. In general, there is a tendency towards continuous reduction in the width and length of dental arches, with increase in crowding, overbite and over jet. The greatest problem has been the inability to determine whether these changes occur primarily as a result of orthodontic treatment, or if they are part of the natural maturation process.^{16,17}

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.¹⁸⁻²⁰

V. CONCLUSION

The present study showed that there is a high significant increase in the inter-premolar width in the mandible, when comparing the wires in the groups (NiTi, CNA, and copper niti). Also, the gender of the patient does not seem to have an Impact of gender on post-treatment efficacy of each wire.

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