

ORIGINAL ARTICLE

**EFFECT OF PREFORMED TAPERED NICKEL TITANIUM
ORTHODONTIC ARCH-WIRES ON MANDIBULAR INTER-CANINE
WIDTH TO PREDICT FUTURE LONG-TERM STABILITY****Sundus Wahid, Najam Ul Hassan, Gulsanga Hassan Khan, Abid Hussain Kanju*, Usman Mahmood**, Emaan Mansoor***, Afsheen Mansoor†, Mudassar Mushtaq Jawad Abbasi††**

Department of Orthodontics and Dentofacial Orthopedics, School of Dentistry, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad, *Department of Orthodontics, Bakhtawar Amin Medical and Dental College Multan, **Department of Science of Dental Materials, Lahore Medical and Dental College, Lahore, ***Islamic International Dental College, Riphah International University, Islamabad, †Department of Science of Dental Materials, School of Dentistry, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad, ††Health Services Academy Islamabad, Pakistan

Background: Maintaining the pre-treatment mandibular inter-canine dimension is crucial for stable post-treatment retention as minor changes can increase post-treatment relapse. This study aimed to identify changes in mandibular inter-canine width caused by active orthodontic treatment using tapered preformed NiTi mandibular arch-wires and predict future stability proportionally. **Methods:** A 6 months' study at School of Dentistry Islamabad involved 60 patients with tapered mandibular arch forms, fully erupted, non-anomalous, and permanent mandibular canines. The patients underwent non-extraction fixed orthodontic mechanical therapy treatment using conventional pre-adjusted edgewise brackets. The study involved detailed clinical examination, orthodontic study casts, orthopantomograms, and lateral cephalograms. The initial pre-treatment mandibular inter-canine width was recorded using digital vernier caliper. After levelling and alignment, the mandibular cast impressions were repeated, and mid-treatment inter-canine width was calculated. **Results:** Statistically significant differences were found between pre-treatment and post-treatment widths. The mean pre-treatment width was 26.81 mm, while the mid-treatment width increased to 27.26 mm after levelling and alignment. Statistically significant differences ($p=0.001$) were found between pre-treatment mandibular inter-canine width (T1) to during treatment mandibular inter-canine width when considering gender. When considering age-wise analysis, there were no statistically significant differences between pre-treatment mandibular inter-canine width (T1) to during treatment mandibular inter-canine width. **Conclusion:** The commercially available preformed tapered NiTi arch-wires alter the original mandibular inter-canine width in patients which have a natural tapered mandibular arch-form, increasing the risk of relapse, hence predicting future long-term instability.

Keywords: Arch-forms, Inter-canine width, Preformed arch-wires, Stability

Pak J Physiol 2025;21(3):46–9, DOI: <https://doi.org/10.69656/pjp.v21i3.1872>

INTRODUCTION

Oral health is extremely imperative for overall physical health, as health is considered as supreme assets of human life.^{1,2} A successful orthodontic treatment involves accurate diagnosis, a detailed treatment plan, careful planning, and a retention strategy.³ A good clinician correlates the morphological arch-form of patients with preformed arch-wires, which helps achieve optimal aesthetics, functional occlusion, and stability.⁴ Arch-wires, metal wires, were initially fabricated in gold alloy, but stainless steel became popular due to its high yield strength and corrosion resistance.⁵ Cobalt Chromium alloy was introduced, but it became obsolete due to heat treatment and additional costs.⁶ Many people can't undertake treatment due to affordability issue in low income nations as socioeconomic status plays a vital role and it is also a predictor of a broad range of outcomes over the course of person's life, including their psychological and physical health.^{7,8}

Australian Arch-wire was developed, and Nickel Titanium arch-wires have been improved over time, becoming the first choice for initial alignment and levelling.⁹ In the modern days, orthodontics has grasped incredible goals and success.¹⁰ Effects of certain procedures has been constantly an issue of concern for both patients and clinician.¹¹ Most people undertake dental treatment to get rid from pain.¹²⁻¹³

Arch-form refers to the overall configuration of the dental arch, considering symmetry, roundness, elongation, and convexity.¹⁴ Chuck was the first to classify arch-forms as tapered, square, and ovoid, and Ricketts correlated various factors like width, size, length, bracket position, and contact details.¹⁵

Research on the impact of anatomical arch-forms on inter-canine width during orthodontic treatment has been limited.¹⁶ Studies have shown that inter-canine widths decrease with treatment in all types of malocclusion and decrease after treatment, suggesting that type of malocclusion doesn't significantly affect long-term stability.¹⁷ There is ongoing debate on the

effects of extraction vs non-extraction therapy, with some researchers advocating extraction and others against it.¹⁸ A randomized clinical trial found no significant differences between self-ligating bracket systems and conventional pre-adjusted edgewise twin brackets during the alignment and levelling phase of orthodontic therapy.¹⁹ However, little is known about the changes brought about by the use of preformed commercially available NiTi arch-wires on the most prevalent arch-forms in Pakistani population.

The objective of this study was to detect the changes in the mandibular inter-canine width brought by the use of tapered preformed NiTi arch-wires during active orthodontic treatment on the tapered mandibular arch-forms and draw the predictability of future stability proportional to these changes.

MATERIAL AND METHODS

The study was conducted at Department of Orthodontics, School of Dentistry, Islamabad, focusing on patients undergoing fixed orthodontic therapy, from May to Oct 2024. Sample size was calculated using WHO sample size calculators with 5% level of significance, 80% Power of test, 2.68 Pooled standard deviation, 94.43 Test value of the population mean, 96.21 anticipated population mean.¹⁹ Final sample size came out to be 60.

Sample was chosen from a pool of patients reporting to the Department, undergoing fixed orthodontic therapy with tapered mandibular arch-forms as determined by template method via non-probability consecutive sampling technique. Ethical permission was taken from the hospital and patients prior to the study.

Sample comprised patients undergoing fixed orthodontic therapy with conventional pre-adjusted Edgewise brackets (0.022*0.028 MBT slot). The arch-wire material used in the treatment patients was commercially available preformed NiTi (Industrial: Ortho-care tapered) with an arch-wire sequence range (NiTi round: 0.012±0.019*0.025 NiTi rectangular). Patients of both genders with permanent erupted mandibular canines and tapered mandibular arch-forms were included in the study. Patients having gross dental anomalies (congenitally missing, ectopic, transposed, impacted teeth, cleft cases, and cleft mandibularis cases) in the mandibular labial segments, mesially or distally tilted canines, non-extraction cases, crowding with less than 5 mm in the anterior segment mandibular segment (between mandibular 3 to 3), severe skeletal malocclusion (Class II div II, Class III skeletal bases), prosthetic crowns on mandibular 3's and cross bites were excluded from the study.

The study involved detailed clinical examination, orthodontic study casts, orthopantomograms, and lateral cephalograms. Data collection procedure was performed by measuring pre-treatment mandibular inter-canine width (T1) and during

treatment mandibular inter-canine width, once levelling and alignment has been achieved (T2). Data collection tools were orthodontic study models, ortho-care arch-wire templates and vernier caliper.

Measurement of pre-treatment mandibular inter-canine width (T1) and during treatment mandibular inter-canine width, once levelling and alignment was achieved (T2) were checked twice by the same observer. The differences in intra observer readings were compared by Cronbach's alpha. The second observer was blinded towards the tested data, calculated pre-treatment mandibular inter-canine widths (T1), during treatment mandibular inter-canine width, once levelling and alignment had been achieved (T2) and transferred the readings on proforma. To reduce the method error, two observers independently calculated pre-treatment inter-canine width (T1) and mid treatment inter-canine width (T2), once levelling and alignment was achieved. The decision to calculate mid treatment inter-canine width (T2) was subjective to both observers when the observers mutually agreed that mandibular arch-form filled the clinical criterion of levelling and alignment, the study models for (T2) were poured in casts followed by measurement of mandibular ICW.

Data analysis was performed on SPSS-22. For each variable, the arithmetic mean and standard deviation was calculated. Intra and inter observer measurements were repeated to rule out errors/biases once data collection had been completed. The data collection procedure, i.e., measurement of inter-canine width at two intervals was standardized amongst observers. The comparison of measurements between inter-observer and intra-observer readings was done with sample *t*-tests, and $p < 0.05$ was considered statistically significant.

RESULTS

Out of 60 patients, 38 were females while 22 were males. Mean±SD for comparison of inter-canine width among both observers are given in Table-1.

Statistically significant differences ($p=0.001$) were found between pre-treatment mandibular inter-canine width (T1) to during treatment mandibular inter-canine width when considering gender, once levelling and alignment was achieved (T2). (Table-2).

When considering age-wise analysis, there was no statistical significant difference ($p=0.129$ and 0.106) between pre-treatment mandibular inter-canine width (T1) to during treatment mandibular inter-canine width. (Table-3).

Table-1: Paired sample *t*-test for comparison of inter-canine width among both observers

Observer	Inter-canine width (T1)	Inter-canine width (T2)	<i>p</i>
Observer 1	26.80±1.30	27.26±1.29	0.000
Observer 2	26.83±1.33	27.22±1.31	0.000

Table-2: Independent sample *t*-test for comparison of inter-canine width among gender distribution

Gender	Observer 1		Observer 2	
	Inter-canine width (T1)	Inter-canine width (T2)	Inter-canine width (T1)	Inter-canine width (T2)
Male	22	22	22	22
Female	38	38	38	38
<i>p</i>	0.003	0.002	0.001	0.001

Table-3: Independent sample *t*-test for comparison of inter-canine width among different age groups

Observer	Inter-canine width	Age group (Yrs)		<i>p</i>
		11-17	18-27	
Observer 1	Inter-canine width (T1)	32	28	0.194
	Inter-canine width (T2)	32	28	0.129
Observer 2	Inter-canine width (T1)	32	28	0.119
	Inter-canine width (T2)	32	28	0.106

DISCUSSION

Past literature has focused on finding an ideal arch-form by analyzing healthy patients in normal occlusion and various patterns of malocclusion.²⁰ The goal of an ideal orthodontic treatment plan is to correct repositioning of teeth according to arch-form configuration for optimal aesthetics, function, and stability.²¹

We evaluated the mandibular inter-canine width change with the use of preformed NiTi arch-wires during active orthodontic treatment. Studies advocate the maintenance of pre-treatment mandibular inter-canine width, with special emphasis on the preservation of the mandibular inter-canine width because this tends to return, in most patients, to its original value after treatment.^{22,23}

After 21 days, this study found a significant increase in mandibular inter-canine width with active fixed orthodontic mechanics during the initial levelling and alignment phase. This increase was consistent across all observers, regardless of age or gender. Gardner made similar conclusions that greatest inter-arch dimensional changes after orthodontic treatment were observed in the mandibular inter-canine width followed by a strong tendency of inter-canine dimension to return to its pre-treatment shape in the retention phase.²⁴

Our study results also confine to another study which concluded that preformed arch-wires significantly increased the arch width dimensions during treatment as compared to the customized arch-wire system.²⁵ One more study concluded that greater the change in ICW dimension during active treatment, the greater the tendency for post-retention relapse.²⁶

A meta-analysis by Burke concluded that mandibular inter-canine width tends to expand during treatment by 0.8 to 2.0 mm, regardless of mechanics.²⁷ Chances of cross infection among dental patients who are going long-term treatment are always there as well.²⁸

In this study, statistically significant differences were found between pre-treatment mandibular inter-canine width (T1) to during treatment

mandibular inter-canine width when considering gender, once levelling and alignment was achieved. This is similar to another study²³ where authors found that after orthodontic treatment, mandibular inter-canine width increased for class II div 2 malocclusion in males and females.²³ This is comparable to another study²⁹ where there were statistically significant differences.

When considering age-wise analysis, there were no statistically significant differences between pre-treatment mandibular inter-canine width to during treatment mandibular inter-canine width. This is in contrast to another study³⁰, where there were statistically significant differences between certain age-groups.

CONCLUSION

The commercially available preformed tapered NiTi arch-wires significantly increase the original pre-treatment mandibular inter-canine width in patients which have a natural tapered mandibular arch-form, hence predicting future long-term instability.

LIMITATIONS

Only Ortho-care preformed NiTi arch-wires were used whereas a number of commercially available preformed arch-wires can have their own implications. Small sample size and short duration were also the limitations of this study.

RECOMMENDATIONS

Our arch-wire composition was NiTi. Comparison of various arch-wire materials like SS, stranded coaxial, heat treated and their effects may provide the clinicians with more insight. In future ovoid and other arch-forms should be correlated along with other popular preformed arch-wires in the market. Future studies with other arch-form variables should be done to advocate the changes induced by preformed arch-wires, and a longer follow-up and longitudinal changes brought by the preformed arch-wires should be studied.

REFERENCES

1. Javaid MM, Farooq F, Khalid SN, Ullah A, Langrial RZ, Junaid M, *et al.* Assessment of periodontal status and oral health-related quality of life among pregnant women. *J Soc Obstet Gynaecol Pak* 2024;14(2):96-100.
2. Javaid MM, Zehra M, Khalid SN, Mahmood U, Ullah A, Kanju AH, *et al.* Association between socio-demographic factors and oral health impact profile of pregnant women. *J Soc Obstet Gynaecol Pak* 2024;14(4):400-4.
3. Mozaffari S, Mousavi T, Nikfar S, Abdollahi M. Common gastrointestinal drug-drug interactions in geriatrics and the importance of careful planning. *Expert Opin Drug Metab Toxicol* 2023;19(11):807-28.
4. Chang J, Mehta S, Chen PJ, Upadhyay M, Yadav S. Correction of open bite with temporary anchorage device-supported intrusion. *APOS Trends Orthod* 2019;9(4):246-51.
5. Thomas GE, Sajith AS, Indira PV. A study of Ni-Ti shape memory alloy-steel fiber hybrid reinforcement in GGBS mortar for corrosion resistance. *Mech Time-Depend Mater* 2023;28(4):2511-30.

6. Harden F, Kral R, Schädel B, Adelung R, Jacobs O. Fabrication of precise non-assembly mechanisms by multi-material fused layer modeling and subsequent heat treatment. *Eng Rep* 2024;6(1):e12693.
7. Javaid MM, Tahir A, Shaikh SP, Qadeer AA, Mansoor A, Sattar M, *et al.* Assessment of parents' satisfaction level regarding health care services provided to their malnourished thalassemic major children. *J Haematol Stem Cell Res* 2025;5(1):93–6.
8. Javaid MM, Ahmad I, Mansoor E, Ali SI, Bairam S, Umair M, *et al.* Socioeconomic status: a lethal weapon in deteriorating the satisfaction level attributed to thalassemia management in Pakistan. *Ann Pak Inst Med Sci* 2024;20(4):795–9.
9. Aydın B, Şenşık NE, Koşkan Ö. Evaluation of the alignment efficiency of nickel-titanium and copper-nickel-titanium archwires in patients undergoing orthodontic treatment over a 12-week period: a single-center, randomized controlled clinical trial. *Korean J Orthod* 2018;48(3):153–62.
10. Fazal A, Khattak O, Chaudhary FA, Hyder M, Javaid MM, Iqbal A, *et al.* Barriers and challenges faced by orthodontists in providing orthodontic care and implementing new innovative technologies in the field of orthodontics among children and adults: a qualitative study. *J Clin Pediatr Dent* 2023;47(4):80–5.
11. Ahmed M, Noor A, Noreen R, Sajid M, Jamil M, Javaid M. Comparison of 0.5 mg dexamethasone and placebo used as premedication for success of inferior alveolar nerve block. *Pak Oral Dent J* 2021;41(3):148–57.
12. Noor N, Mujtaba H, Humayoun S, Umer MF, Javaid MM, Rehman A. Comparison of endodontic pain observed with sodium hypochlorite, hydrogen peroxide and normal saline-based root canal irrigants. *Ann Pak Inst Med Sci* 2022;18(1):3–8.
13. Noor N, Azhar R, Sartaj R, Mujtaba H, Humayoun S, Javaid MM, *et al.* Severity of post obturation pain in single versus multiple sittings endodontic treatment using rotary nickel titanium instruments. *Ann Pak Inst Med Sci* 2023;19(3):220–4.
14. Han S, Wang C, Liu X, Li B, Gao R, Li S. A random algorithm for 3D modeling of solid particles considering elongation, flatness, sphericity, and convexity. *Comp Part Mech* 2023;10(1):19–44.
15. Alghamdi M, Tashkandi N. Relationship between dental arch parameters and mandibular plane angle. *J Adv Med Dent Sci Res* 2022;10(5):105–22.
16. Garg H, Khatria H, Kaldhari K, Singh K, Purwar P, Rukshana R. Inter-molar and intercanine width changes among Class I and Class II malocclusions following orthodontic treatment. *Int J Clin Pediatr Dent* 2021;14(Suppl 1):S4–9.
17. Peter E, Monisha J, Benson PE, George SA. Does orthodontic treatment improve the oral health-related quality of life when assessed using the Malocclusion Impact Questionnaire? A 3-year prospective longitudinal cohort study. *Eur J Orthod* 2023;45(6):773–80.
18. McLaren D, Willis R, Szerszynski B, Tyfield D, Markusson N. Attractions of delay: using deliberative engagement to investigate the political and strategic impacts of greenhouse gas removal technologies. *Environ Plan E Nat Space* 2023;6(1):578–99.
19. Fleming PS, DiBiase AT, Sarri G, Lee RT. Comparison of mandibular arch changes during alignment and leveling with two preadjusted edgewise appliances. *Am J Orthod Dentofacial Orthop* 2009;136(3):340–7.
20. Nojima K, McLaughlin RP, Isshiki Y, Sinclair PM. A comparative study of Caucasian and Japanese mandibular clinical archforms. *Angle Orthod* 2001;71(3):195–200.
21. Pan J, Lu Y, Liu A, Wang X, Wang Y, Gong S, *et al.* Expert consensus on orthodontic treatment of protrusive facial deformities. *Int J Oral Sci* 2025;17(1):5.
22. Myser SA, Campbell PM, Boley J, Buschang PH. Long-term stability: postretention changes of the mandibular anterior teeth. *Am J Orthod Dentofacial Orthop* 2013;144(3):420–9.
23. Wazir ZU, Iftikhar A, Mushtaq N. Mandibular intercanine width in pre and mid orthodontic treatment in extraction and non-extraction cases. *Pak Orthod J* 2021;13(2):67–71.
24. Gardner SD, Chaconas SJ. Post-treatment and post-retention changes following orthodontic therapy. *Angle Orthod* 1976;46(2):151–61.
25. Weaver KE, Tremont TJ, Ngan P, Fields H, Dischinger T, Martin C, *et al.* Changes in dental and basal archforms with preformed and customized archwires during orthodontic treatment. *Orthod Waves* 2012;71(2):45–50.
26. de la Cruz A, Sampson P, Little RM, Artun J, Shapiro PA. Long-term changes in archform after orthodontic treatment and retention. *Am J Orthod Dentofacial Orthop* 1995;107(5):518–30.
27. Burke SP, Silveira AM, Goldsmith LJ, Yancey JM, Van Stewart A, Scarfe WC. A meta-analysis of mandibular intercanine width in treatment and postretention. *Angle Orthod* 1998;68(1):53–60.
28. Javaid M, Chaudhary FA, Fazal A, Khan EA, Hyder M, Din SU. Mode of transmission of COVID-19, oral manifestations, precautionary measures/clinical strategies and treatment considerations in dentistry. *Pak J Med Health Sci* 2022;16(1):3–6.
29. Tabassum H, Hussain S, Rizwan S, Jan K, Salman S, Baloch MA. Maxillary and mandibular interarch width among different malocclusions. *Pak J Med Health Sci* 2023;17(2):727–9.
30. Balaraman C, Asokan S, GeethaPriya PR, YogeshKumar TD, Viswanath S. Mandibular intercanine width at three stages of mixed dentition in children at Namakkal district: a cross-sectional study. *Int J Clin Pediatr Dent* 2024;17(7):737–41.

Address for Correspondence:

Dr Afsheen Mansoor, Associate Professor, Department of Science of Dental Materials, School of Dentistry, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad, Pakistan.

Email: drafsheenqamar@gmail.com

Received: 9 Jul 2025

Reviewed: 18 Sep 2025

Accepted: 27 Sep 2025

Contribution of Authors:

SW: Wrote introduction

AHK: Results section

AM: Drafting

NUH: Wrote discussion

UM: Data collection

MMJA: Wrote methodology

GHK: Wrote methodology

EM: Result section

Conflict of Interest: None

Funding: None