Original Article

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Clinical Implications of Preformed Archwire Selection on the Treatment of Angle Class I/II division 1 Malocclusions in Thais

Dentistry Section

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ABSTRACT

Introduction: The dental arch forms were compared of untreated Class I and Class II div 1 malocclusions to those of non-customized preformed archwires manufactured by American Orthodontics, G&H, Highland, Ormco, RMO, and 3MUnitek. Arch forms of post-treatment Class II div 1 malocclusions treated by four 1st premolar extractions are also compared.

Materials and Methods: Four metrics of archform shape and size (canine and 1st molar depth and inter-canine and inter 1st molar width) were measured on dental casts of 40 Class I and 22 Class II div 1 patients. These same metrics were also used to describe preformed archwire forms.

Results: Non-customized preformed wires all showed significantly narrowed mandibular arch forms. This was true for maxillary archwires, with four exceptions. The Highland Natural Arch form, G&H True form I, and RMO natural preformed archwires showed both inter-canine and 1st molar widths statistically the same as mean dental arch widths in both the untreated and post-treatment Class II groups. In Class I patients, these three archwires showed only inter-canine widths equivalent to dental measurements. The Highland Progressive archwire matched only the 1st molar width in the untreated Class II group.

Conclusion: None of these archwires – if used unadjusted, will produce a significant expansive force in either the maxillary or mandibular arch. Three maxillary non-customized preformed archwires showed both inter-canine and 1st molar arch widths statistically the same as Thai Class II div 1 dental arch dimensions. Using them to treat this malocclusion should minimally affect both pre and post-treatment maxillary arch form.

Keywords: Dental arch, Nickel-titanium (NiTi) wires, Orthodontic treatment

INTRODUCTION

The introduction of preformed archwires and new bracket designs in orthodontic practice has greatly changed orthodontic practice and reduced patient chair time. An increasing variety of new archwire materials have also become available. Nickel-titanium (NiTi) wires are now used in the majority of cases for initial leveling and aligning [1]. However, their super elastic property makes customization of arch form and size difficult. In order to maintain pre-treatment arch forms, it is more reasonable to have different types of preformed arch wires available that operator could choose to most closely match the patient's pretreatment arch form.

A study of clinicians' choices when selecting arch wires during the initial and latter stages of orthodontic treatment report that clinicians use available preformed NiTi archwire in the early stage and stainless steel in the latter stage of treatment for preservation of the pre-treatment arch form. In particular, maintaining of the initial intercanine and intermolar widths were considered important in stability [2-4].

Because the treatment philosophy in our clinic is to maintain pre-treatment arch forms throughout treatment, we match non-customized preformed NiTi archwires to individual patient archforms during treatment planning. This selection is usually made by visual comparison of archwires placed against the facial surfaces of both mandibular and maxillary dental casts. It has always been of interest to be more quantitative in this selection process. With this in mind, we designed a study to compare average dental arch forms of Class I and Class II div 1 malocclusions to those of the preformed NiTi archwires currently used which are the two most common malocclusion seen in our clinic.

MATERIALS AND METHODS

Subject Selection

Groups of Angle Class I and Class II div 1 patients were selected from patient records at the Mahidol University Dental School Graduate Orthodontic Clinic.

Selection criteria for the Class I study group were: (1) meets all of Angle's classification I criteria, (2) no cusp attrition, fractured teeth, or restorations extending to contact areas, cusp tips or incisal edges, (3) complete permanent dentition with normal size and shape including fully erupted 2nd molars, (4) arch length discrepancy less than 3 mm, (5) no history of prior orthodontic treatment.

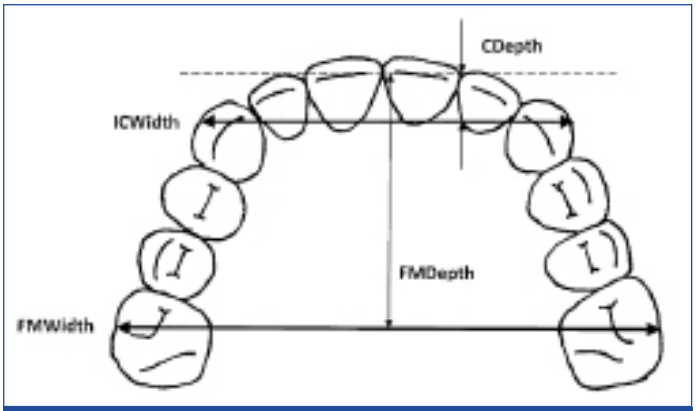
Selection criteria for the Class II, division 1 study group were: (1) meets all of Angle's classification II, division 1 criteria, (2) age 17–25 y at the start of treatment, (3) overjet between 4 and 9 mm, (4) complete permanent dentition with normal size and shape including fully erupted 2nd molars, (5) no cusp attrition, fractured teeth, or restorations extending to contact areas, cusp tips or incisal edge, (6) no previous adjunctive appliance treatment as part of their orthodontic treatment -- such as a quad helix appliance, functional appliance, or rapid palatal expander, (7) patients were to be treated by four 1st premolar extractions as part of a comprehensive orthodontic treatment plan, (8) post-treatment dental casts were available at least one year into retention.

Using the above criteria, 40 Class I (20 male, 20 female) and 22 Class II, division 1 (8 male, 14 female) were selected.

A third study group was defined comprised of the post-treatment Angle class II, division 1 patients (n=22). This group was added to the study because extraction cases are reported to show significant permanent arch form changes [3]. It was of interest to determine how well the non-customized preformed arch wires matched both early treatment and post-treatment arch forms.

Dental Arch form Landmark Definitions

Dental arch form was described by four landmarks – arch width and depth (midline length) at canine and 1st molar locations from proximal first inter-incisal contact point [Table/Fig-1] [5].



[Table/Fig-1]: Arch Form Metrics [5]

Preformed Archwire Selection

Twelve preformed archwires from six manufacturers were selected. These companies were 3MUnitek, Highland, G&H, American Orthodontics, RMO, and Ormco. Five of the archwires have also been used in similar published studies of Caucasian, Japanese, and Indian Class I malocclusions [Table/Fig-2]. Identification numbers were assigned to each of the archwire forms tested. [Table/Fig-3] lists this information along the different types of wire material available. This particular set of archwires was selected because of their availability and common use in our clinic.

Digitizing Plaster Cast Landmarks

The desired bracket positions for each tooth were marked on casts with pencil [Table/Fig-4].

Manufacturer	Archwire Form Trade Name	Studies					
		White [6] 1978 USA n=24(I)	Felton [7] 1987 USA n=30(I) n=30(II)	Braun [8] 1999 USA n=15(I)	Oda [9] 2010 Japan n=30(I)	Bhowmik [10] 2012 India n=40(I)	Present study Thailand n=40(I) n=22(II)
AmOrth, USA	Natural Arch Form I				x	x	X
	Natural Arch Form II				x	x	
	Natural Arch Form III				x		
Dentsply-Sankin, Japan	Tynilloy (large)				x		
	Tynilloy (small)				x		
Dentaurum, Gb	Proform Arch Shape					x	
GAC, USA	Accu Form				x		
	Standard Form				x		
G&H, USA	True Form I						X
	Europa Form I						X
Highland, USA	Mid size (maxillary only)						X
	Natural Arch Form						X
	Progressive Arch Form						X
Lancer, USA						x	
Libral T, India	Euroform					x	
Modern O, India	Natural Form					x	
	Orthoform					x	
Oral Care, Japan	Smooth Arch Form				x		
Orange O, India						x	
Ormco, USA	Broad Arch (large)			x	x		
	Broad Arch (small)			x	x		X
	Orthos (large)			x	x		
	Orthos (small)			x	x		
	Vari-Simplex (large)		x		x		
	Vari-Simplex (small)		x		x		
	Tru-Arch (medium)		x		x		
	Tru-Arch II (medium)			x	x		
	Par arch form		x				
Ortho Org, USA	Proform				x	x	
Orthotec, USA	Nuform					x	
RMO, USA	Natural Arch Form						X
	Ideal Arch Form						X
	Pentamorphic		x				
SIAOrth, Italy	Standard Shape					x	
	Natural Shape					x	
Template Forms	Bonwill-Hawley	x					
	Brader	x	x				
	Cantenary curve	x					
	RMDS	x					
3MUnitek, USA	Orthoform I,(tapered)			x	x	x	X
	Orthoform II,(square)			x	x	x	X
	Orthoform III, (ovoid)				x	x	X

[Table/Fig-2]: Preformed archwire sets tested in comparative dental arch form studies
AmOrth = American Orthodontics, Lancer = Lancer Orthodontics , Libral T = Libral Traders, Modern O = Modern Orthodontics, Orange O = Orange Orthodontics, Ortho Org = Ortho Organizers, RMDS = Rocky Mountain Data Systems, RMO = Rocky Mountain Orthodontics, SIAOrth = SIA Orthodontics, n = sample size, I = Class I, II=Class II

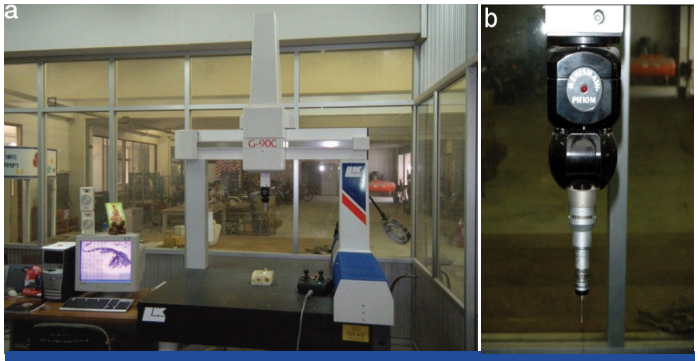
Archwire ID number	Manufacturer	Archwire Form Trade Name	Available Archwire Materials
1	3M Unitek	Orthoform I, tapered	NiTi (superelastic and heat activated), beta-Titanium, and stainless steel(solid)
2		Orthoform II, standard	
3		Orthoform III, ovoid	
4	Highland	Mid size (only maxillary arch used)	NiTi (superelastic and heat activated) and stainless steel (solid and braided)
5		Natural arch form	
6		Progressive arch form	
7	G&H	True form I	NiTi (superelastic and heat activated), beta-Titanium, and stainless steel (solid and braided)
8		Europa form I	
9	American Orthodontics	Natural arch form I	NiTi (superelastic and heat activated), beta-Titanium, and stainless steel (solid and braided)
10	RMO	Natural arch form	NiTi (superelastic and heat activated), Elgiloy,stainless steel (solid),CuNiTi, and TiMo (Natural arch form only)
11		Ideal arch form	
12	Ormco	Broad arch, small	NiTi (superelastic and heat activated), stainless steel (solid and braided),CuNiTi, beta-Titanium, and Titanium-Niobium

[Table/Fig-3]: Assignment of archwire identification numbers

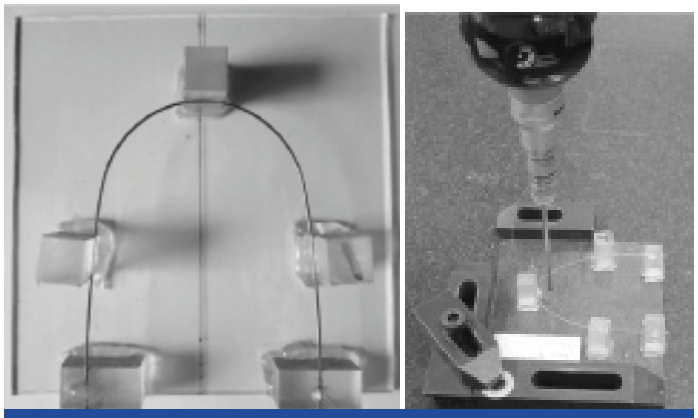
[Table/Fig-4]: Dental cast sample

A LK Tools G-90C measuring instrument was used to digitize the plaster cast landmarks [Table/Fig-5a&b]. This coordinate measuring machine (CMM) uses a frictionless air bearing touch probe to record XYZ spatial coordinates. To digitize landmarks, dental casts were first positioned with all incisal edges and cusp tips in a fixed plane. The digitizing instrument allows one to measure arch depth and width by moving it between marked landmarks and recording the effective distance between points in the XY space. Moving the touch probe over a straight line showed it to have a linear accuracy of 6 microns and reproducibility of 4 microns.

All dental casts were measured by the same technician. A reproducibility study was conducted to evaluate measurement accuracy. Randomly at 4 weeks intervals, the technician repeated measurements on several sets of dental casts. Analysis of these results showed less than 0.5% measurement error.



[Table/Fig-5a&b]: (a) LK Tools G-90C Machine. **(b)** LK Tools G-90C Probe



[Table/Fig-6]: Top view of holding fixture **[Table/Fig-7]:** Probe measurement of ICW

Digitizing Preformed Archwire Landmarks

Although NiTi archwires are used for treatment, the arch forms actually measured were stainless steel 0.019 x 0.025 wires with the same arch form. They were used because of their greater rigidity and tensile strength for mounting. To digitize landmarks, wires were first mounted to a glass plate holding fixture [Table/Fig-6]. They were aligned over two reference lines marking the center of each glass plate. Once aligned, wires were held in place by five acrylic blocks (1x1x2 cm) glued with a structural acrylic adhesive (3M®, USA). The digitizing probe first measured the mean canine dental arch depth for each study group [Table/Fig-7]. It was then moved perpendicular to this landmark to measure the wire's inter-canine width. The inter first molar width was measured in a similar fashion – using the mean first molar arch depth. Ten samples of each preformed archwire type were digitized. A reproducibility study was conducted by the technician on 24 maxillary and 22 mandibular different archwires. Analysis of these results showed less than 0.5% measurement error.

STATISTICAL ANALYSIS

Means, standard deviations, and medians of the measured dental arch widths and depths were calculated with SPSS software (version 17; SPSS, Chicago Ill). The confidence intervals for inter-canine and inter first molar widths were calculated with Microsoft Excel. The distributions of mean preformed archwire widths at the canine and first-molar levels were graphically compared with the corresponding confidence intervals for the untreated Class I and II div 1 and post-treatment Class II div 1 groups.

RESULTS

[Table/Fig-8] shows the mean dental arch depths for the three Thai populations studied. Both maxillary and mandibular canine arch depths were found to be statistically the same for all groups. First molar arch depths were the same in both arches for untreated Class I and Class II div 1 groups only. However, the post-treatment Class II mean 1st molar depth was significantly shorter in both the maxilla and mandible. This difference is estimated to be between 4 to 9 mm in the maxillary and 1 to 8 mm in the mandibular arch.

	[1] Class I Untreated (n=40)			
	Maxillary Arch		Mandibular Arch	
	Mean ±(SD)	CI(0.99)†	Mean ±(SD)	CI(0.99)
Canine Arch Depth	9.0± (2.1)	8.2 - 9.8 (mm)	5.1± (2.3)	4.2–6.0 (mm)
First Molar Arch Depth	31.3 ±(2.0)	30.5– 32.1 (mm)	26.4± (2.0)	25.6– 27.2 (mm)
	[2] Class II division 1 Untreated (n=22)			
	Maxillary Arch		Mandibular Arch	
	Mean± (SD)	CI(0.99)	Mean± (SD)	CI(0.99)
Canine Arch Depth	8.6± (1.9)	7.6–9.6 (mm)	5.0 ±(1.9)	4.0–6.0 (mm)
First Molar Arch Depth	31.7± (1.9)	30.7–32.7 (mm)	26.4± (1.7)	25.5–27.3 (mm)
	[3] Class II division 1 Post-Treatment Four 1st Premolar Extraction (n=22)			
	Maxillary Arch		Mandibular Arch	
	Mean± (SD)	CI(0.99)	Mean± (SD)	CI(0.99)
Canine Arch Depth	9.0± (2.0)	8.0–10.0 (mm)	5.5± (1.8)	4.5–6.5 (mm)
First Molar Arch Depth	24.9± (2.1)	23.8–26.0 (mm)	20.4± (2.2)	19.2–21.6 (mm)

[Table/Fig-8]: Mean dental arch depth at the canine and first molars for thai sample populations
†CI(0.99) = confidence interval of measurement's mean value at 99% probability

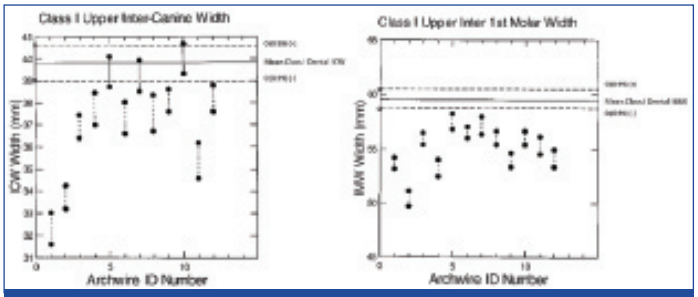
	[1] Class I Untreated (n=40)			
	Maxillary Arch		Mandibular Arch	
	Mean ±(SD)	CI(0.99)†	Mean± (SD)	CI(0.99)
Inter Canine Width	39.8± (1.9)	39.0–40.6 (mm)	31.0± (1.5)	30.4–31.6 (mm)
Inter First Molar Width	59.5± (2.3)	58.6–60.4 (mm)	53.4± (2.0)	52.6–54.2 (mm)
	[2] Class II division 1 Untreated (n=22)			
	Maxillary Arch		Mandibular Arch	
	Mean± (SD)	CI(0.99)	Mean± (SD)	CI(0.99)
Inter Canine Width	39.4± (2.5)	38.1– 40.7 (mm)	30.6± (2.5)	29.3–31.9 (mm)
Inter First Molar Width	58.2± (2.9)	56.7– 59.7 (mm)	53.6± (2.5)	52.3–54.9 (mm)
	[3] Class II division 1 Post-Treatment Four 1st Premolar Extraction (n=22)			
	Maxillary Arch		Mandibular Arch	
	Mean± (SD)	CI(0.99)	Mean± (SD)	CI(0.99)
Inter Canine Width	40.1± (1.8)	39.1–41.1 (mm)	31.4± (1.7)	30.5–32.3 (mm)
Inter First Molar Width	55.8± (2.5)	54.5–57.1 (mm)	50.6± (2.0)	49.5–51.7 (mm)

[Table/Fig-9]: Mean dental arch widths at the canine and first molars for thai sample populations
†CI(0.99) = Confidence interval of measurement's mean value at 99% probability

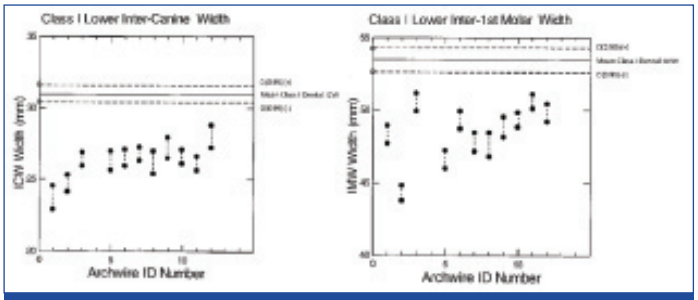
[Table/Fig-9] shows both the maxillary and mandibular dental inter-canine and 1st molar arch widths were statistically the same in all three study groups.

[Table/Fig-10-15] compare the mean inter-canine and 1st molar widths for group dental arches and the 12 preformed archwire forms studied. [Table/Fig-16] summarizes this information.

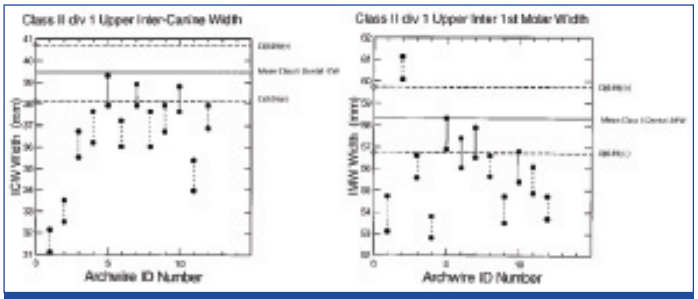
The maxillary arch Class I group shows 3 of the 12 selected archwires have inter-canine widths statistically the same as the dental inter-canine widths. These particular wires are Highland Natural arch form, G&H True form I, and RMO Natural arch form.



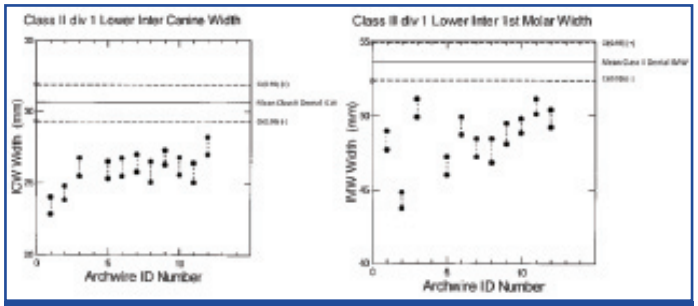
[Table/Fig-10]: Comparison of class I dental inter-canine (left) and first molar widths (right) to maxillary preformed archwires



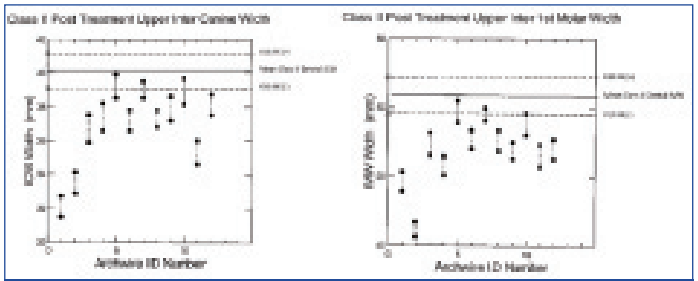
[Table/Fig-11]: Comparison of class I dental inter-canine (left) and first molar widths (right) to mandibular preformed archwires



[Table/Fig-12]: Comparison of class II div 1 dental inter-canine (left) and first molar widths (right) to maxillary preformed archwires



[Table/Fig-13]: Comparison of Class II div 1 dental inter-canine (left) and first molar widths (right) to mandibular preformed archwires

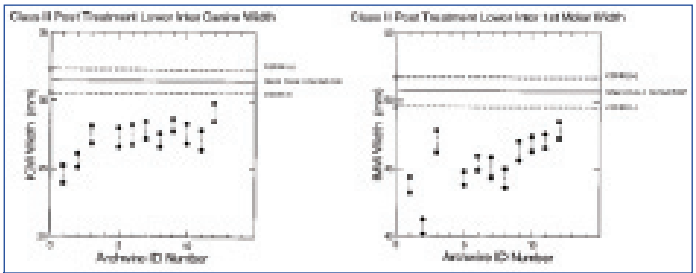


[Table/Fig-14]: Comparison of Class II div 1 post-treatment dental inter-canine (left) and first molar widths (right) to maxillary preformed archwires

All archwire 1st molar widths are significantly less than the dental 1st molar widths. These differences range between 1 to 11 mm. In both the Class II untreated and post-treatment groups, the same three archwires above showed both inter-canine and 1st molar widths statistically the same as the dental arch measurements.

An additional archwire showed the same 1st molar width as the untreated Class II group. This was the Highland Progressive arch form wire. All other preformed archwires tested showed canine and molar widths significantly narrower than the dental widths.

The mandibular dental arches for all malocclusion study groups showed both dental inter-canine and 1st molar widths statistically wider than all of the preformed archwires tested. These differences ranged between 2 and 10 mm.



[Table/Fig-15]: Comparison of Class II div 1 post-treatment inter-canine (left) and first molar widths (right) of mandibular preformed archwires

DISCUSSION

[Table/Fig-17] compares our results for Class I patients to those of three earlier studies of comparative arch form width. Braun reports 3MUnitek's Orthoform I and II wires and Ormco's Broad arch form have significantly larger inter-canine and first molar widths compared to dental arch forms in both maxillary and mandibular arches of Caucasian patients [8]. Comparing the mandibular arch of Japanese Class I patients to common archwire forms, Oda reports 3M Unitek Orthoform I and III wires have significantly smaller inter-canine and first molar widths [9]. In contrast, 3M Unitek's Orthoform II and Ormoco small Broad arch form wires had inter-canine widths equal to the mean dental width. However, the first molar width in these two particular wires was significantly less than the dental measurements. Bhowmik studied 3M Unitek Orthoform I,II, and III and American Orthodontics Natural arch preformed archwires in male and female patients from India [10]. With few exceptions, all archwires had significantly larger inter-canine and first molar widths in both the maxilla and mandible. An exception was the Orthoform II standard archwire. It had significantly smaller arch inter-canine and first molar widths in male mandibular arches.

Archwire ID	Company	Class I untreated (n=40)				Class II div 1 untreated (n=22)				Class II div 1 post treatment (n=22)			
		Maxillary		Mandibular		Maxillary		Mandibular		Maxillary		Mandibular	
		ICW	FMW	ICW	FMW	ICW	FMW	ICW	FMW	ICW	FMW	ICW	FMW
1	3MUnitek	L	L	L	L	L	L	L	L	L	L	L	L
2		L	L	L	L	L	L	L	L	L	L	L	L
3		L	L	L	L	L	L	L	L	L	L	L	L
4	Highland	L	L	L	L	L	L	L	L	L	L	L	L
5		EQ	L	L	L	EQ	EQ	L	L	EQ	EQ	L	L
6		L	L	L	L	L	EQ	L	L	L	L	L	L
7	G&H	EQ	L	L	L	EQ	EQ	L	L	EQ	EQ	L	L
8		L	L	L	L	L	L	L	L	L	L	L	L
9	AmOrtho	L	L	L	L	L	L	L	L	L	L	L	L
10	RMO	EQ	L	L	L	EQ	EQ	L	L	EQ	EQ	L	L
11		L	L	L	L	L	L	L	L	L	L	L	L
12	Ormco	L	L	L	L	L	L	L	L	L	L	L	L

[Table/Fig-16]: Comparison of non-customized preformed archwire and dental inter-canine and 1st molar arch widths for thai class I and class II div1 malocclusions
Key: ICW=inter-canine width, FMW=inter first molar width, EQ=archwire and dental arch widths are statistically equal, G=archwire width is greater than dental arch width, L=archwire width is less than dental arch width

Archwire ID	Company	Archwire Trade Name	Study	Race		Maxillary		Mandibular	
						ICW	FMW	ICW	FMW
1	3MUnitek	Orthoform I tapered	Braun [8]	Caucasian		*GT*	*GT*	*GT*	*GT*
			Oda [9]	Japanese				*LT*	*LT*
			Bhowmik [10]	India	M/F	*GT*	*GT*	*GT*	*GT*
			Thailand	Thai		*LT*	*LT*	*LT*	*LT*
2	3MUnitek	Orthoform II standard	Braun	Caucasian		*GT*	*GT*	*GT*	*GT*
			Oda	Japanese				EQ	LT
			Bhowmik	India	F	*GT*	*GT*	GT	GT
					M	*GT*	*GT*	LT	LT
			Thailand	Thai		*LT*	*LT*	*LT*	*LT*
3	3MUnitek	Orthoform III, ovoid	Oda	Japanese				*LT*	*LT*
			Bhowmik	India	M/F	*GT*	*GT*	*GT*	*GT*
			Thailand	Thai		*LT*	*LT*	*LT*	*LT*
9	AmOrtho	Natural arch form	Oda	Japanese				EQ	LT
			Bhowmik	India	M/F	*GT*	*GT*	*GT*	*GT*
			Thailand	Thai		*LT*	*LT*	*LT*	*LT*
12	Ormco	Broad arch, small	Braun	Caucasian		*GT*	*GT*	*GT*	*GT*
			Oda	Japanese				EQ	LT
			Thailand	Thai		*LT*	*LT*	*LT*	*LT*

[Table/Fig-17]: Summary of preformed archwire inter-canine and first molar widths compared to dental class i measurements
Key: ICW=inter-canine width, FMW=inter first molar width, EQ=archwire and dental arch mean widths are statistically equal, GT=archwire width is greater than dental arch width, LT=archwire width is less than dental arch width, M=male, F=female

Our results confirm previously published works [8-10] indicating that preformed archwires are available matching both the inter-canine and first molar widths of dental arches. However, the need to stock many different commercial archwires to find a few such wires matching a particular dental arch form is not economical. Rather, there remains a need to customize wires. If not for the difficulty adjusting NiTi type materials, some of the current discussion on whether to use non-customized preformed NiTi archwires would be unnecessary [11,12]. Rather, individualization of super-elastic wires could begin early in treatment during initial leveling. Instead, such adjustments generally begin after progression to heavier wires in later treatment [13].

Our study has several limitations. The sample size is relatively small – 40 Class I and 22 Class II patients. However, this is a common problem found in other studies as well. The average sample size for the prior five studies ranged from 15 to 40 patients. Also, our methodology does not take into consideration bracket thickness and variable slot depth. The anteroposterior repositioning of archwires at the incisors because of bracket thickness changes width measurements at the canine and first molar levels. Oda et al report the average bracket thicknesses in their study was 0.8 mm. Finally, our conclusions are based on showing only statistically similarity of the inter-canine and 1st molar widths. Comparison of continuous archwire and dental arch forms is not possible with the methodology used [14,15].

CONCLUSION

The primary objective of this study was to determine whether the arch forms of a particular set of non-customized preformed orthodontic archwires differ significantly from those of untreated Class I and Class II division 1 malocclusions. In addition, whether four first premolar extraction treatment changes dental arch form in the group of Class II div 1 patients was also observed.

In all three study groups, the mandibular arch preformed archwires had canine and molar widths significantly less than the dental arch measurements. If used unadjusted, they would be expected to narrow the dental arch form.

With few exceptions, maxillary preformed archwires also had both inter-canine and first molar widths significantly less than dental arch measurements for both Class I and Class II div 1 patients. A few exceptions were found in all three study groups. In the Class II groups, three archwires had both inter-canine and first molar widths statistically equal to the mean dental arch values. These archwires were Highland Natural arch form, G&H True form I, and American Orthodontics Natural arch form I. Additionally, the untreated Class II first molar width was also matched by Highland's Progressive archwire molar width. The maxillary Class I dental arch was significantly wider than all preformed archwires with three exceptions. These were also Highland Natural arch form, G&H True form I, and American Orthodontics Natural arch form I archwires. However, in these cases, only the inter-canine widths were equal to dental mean widths. Inter first molar widths were all significantly less than dental measurements.

Without adjustment, neither the maxillary nor mandibular preformed archwires studied will produce a significant expansive force in Thai patients. Rather, they are all as a group either constrictive or neutral in form.

Three maxillary preformed archwires can be used in Class I and Class II div 1 malocclusions without affecting the dental arch form significantly. These are Highland Natural arch form, G&H True form, and American Orthodontics Natural arch form I.

REFERENCES

[1] McNamara C, Drage KJ, Sandy JR, Ireland AJ. An evaluation of clinicians' choices when selecting archwires. *Eur Jour Orthod*. 2010;32:54-59.
[2] Shapiro PA. Mandibular dental arch form and dimension: Treatment and postretention changes. *Am J Orthod*. 1974;66(1):58-70.
[3] De La Cruz A, Sampson P, Little RM, Artun J, Shapiro PA. Long-term changes in arch form after orthodontic treatment and retention. *Am J Orthod Dentofacial Orthop*. 1995;107:518-30.
[4] Burke SP, Silveira AM, Goldsmith J, Yancey JM, Stewart AV, Scarfe WC. A meta-analysis of mandibular intercanine width in treatment and postretention. *Angle Orthodontist*. 1998;68:53-60.
[5] Jacobs T. Archwire Select: Instructions. http://archwireselect.com/?page_id=6.
[6] White LW. Individualized ideal arches. *J Clin Orthod*. 1978:12: 779-87.
[7] Felton JM, Sinclair PM, Jones DL, Alexander RG. A computerized analysis of the shape and stability of mandibular arch form. *Am J Orthod Dentofacial Orthop*. 1987:92:478-83.
[8] Braun S, Hnat WP, Leschinaky R, Legan HL. An evaluation of the shape of some popular nickel titanium alloy preformed arch wires. *Am J Orthod Dentofacial Orthop*. 1999;116:1-12.
[9] Oda S, Arai K, Nakahar R. Commercially available archwire forms compared with normal dental arch forms in a Japanese population. *Am J Orthod Dentofacial Orthop*. 2010;137:520-27.
[10] Bhowmik AG, Hazare PV, Bhowmik H. Correlation of the arch forms of male and female subjects with those of preformed rectangular nickel-titanium archwires. *Am J Orthod Dentofacial Orthop*. 2012;142:364-73.
[11] Miura F, Mogi M, Ohura Y, Hamanaka H. The super-elastic property of the Japanese NiTi alloy wire for use in orthodontics. *Am J Orthod Dentofacial Orthop*. 1986;90:1:1-10.
[12] Brauchi LM, Keller H, Senn S, Wichelaus A. Influence of bending mode on the mechanical properties of nickel-titanium archwires and correlation to differential scanning calorimetry measurements. *Am J Orthod Dentofacial Orthop*. 2011;139:e449-54.
[13] Al-Sanea JA. Evaluation of dental arch form changes treated with Damon™ arch forms. University of Illinois at Chicago Master Thesis, 2008.
[14] BeGole EA, Fox DL, Sadowsky C. Analysis of change in arch form with premolar expansion. *Am J Orthod Dentofacial Orthop*. 1998;113:307-15.
[15] Begole EA, Lyew RC. A new method for analyzing change in dental arch form. *Am J Orthod Dentofacial Orthop*. 1998;113:394-401.

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