

# A Prospective Clinical Trial of Arch Width Changes Evaluated through Dental Casts in Consecutively Treated Non-extraction and Extraction Cases

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## Abstract

**Objective:** To compare the dental arch width changes in consecutively treated extraction and non-extraction Class I patients.

**Materials and methods:** Anterior and posterior arch widths of the maxillary and mandibular arches of 21 patients treated by 4 first-premolar extraction and 20 patients treated without extractions were measured on study models using a digital caliper. The initial mean ages were  $13.4 \pm 1.02$  years for the extraction group and  $13.1 \pm 1.7$  years for the non-extraction group. Mean treatment time was  $2.7 \pm 0.6$  years for the extraction group and  $2.4 \pm 1.0$  years for the non-extraction group. The maxillary and mandibular crowding were  $-5.2 \pm 2.8$  and  $-5.9 \pm 3.1$  mm for the extraction group and  $-4.1 \pm 2.7$  and  $-3.3 \pm 2.5$  mm for the non-extraction group, respectively. To compare the changes between groups, independent samples t-tests were performed.

**Results:** At the end of treatment, no differences were found between the groups in maxillary intercanine width. The maxillary and mandibular intermolar widths decreased significantly for the extraction group ( $-0.74$ mm and  $-1.59$ mm, respectively) compared with non-extraction ( $1.30$ mm and  $0.37$ mm, respectively). The mandibular intercanine width increased significantly for the extraction group ( $1.48$ mm) compared with non-extraction group ( $0.52$ mm).

**Conclusions:** Orthodontic treatment with extractions of four first premolars in Class I patients provided no significant difference in maxillary intercanine width after treatment compared to nonextraction. However, nonextraction treatment produced significantly larger values in maxillary and mandibular intermolar widths than that in the extraction group.

**Keywords:** Arch width changes; Fixed appliance; Extraction and non-extraction treatment

## Introduction

Considerable controversy still surrounds the question of whether better treatment is achieved by extraction or by non-extraction Class I treatment in patients with minimal to moderate crowding. It is expected that arch dimensional changes occur in both treatment approaches [1-8].

Many studies [3-6] have documented that increases in dental arch length and width during orthodontic treatment tend to return toward pretreatment values after retention. Another issue is the assumption that extraction treatment should result in narrower dental arches. Also related is the perception that extraction treatment is associated with less esthetic smiles due to the appearance of unaesthetic black triangles at the corners of the mouth and 'negative' spaces lateral to the buccal segments [9,10]. However, arch width, at least in the intercanine zone, is not necessarily narrower after extraction treatment when compared with non-extraction treatment [11,12]. For example, in comparable groups of patients treated with and without extractions, the post-treatment intercanine widths of the maxillary and mandibular arches were the same in both groups [11].

Weinberg and Sadowsky [13] in a retrospective study of Class I malocclusion cases treated non-extraction, found significant increases in the mandibular intercanine and intermolar arch widths and stated that the resolution of the crowding in the non-extraction therapy of Class I malocclusion was achieved by expansion of the buccal segments

in mandibular arch. In borderline patients, the long-term increase of the mandibular intercanine width in those treated by extraction therapy was 1.0 mm, whereas the increase in the non-extraction sample was only 0.5 mm [12]. At the end of treatment, the intercanine widths of both groups were the same.

However, Luppappornlarp and Johnston [11] evaluated the post-treatment and long-term results of treatment in clear-cut extraction and non-extraction patients and noted that the mandibular intercanine dimension of the extraction subjects was greater at all stages examined than the same parameter in the non-extraction patients. These data indicate that there is no systematic narrowing of the dental arches as a result of 4 first-premolar extraction treatment.

To our knowledge, a few articles [7,8,14] have retrospectively

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addressed the arch width changes after extraction and non-extraction therapies but none prospectively. Prospective studies, in comparison to retrospective studies, are less likely to bias. The purpose of this prospective study of consecutively treated patients was to compare the dental arch width changes of Angle Class I patients after both non-extraction and four first premolar extraction therapies and to determine the changes in arch widths that occurred during treatment.

## Materials and Methods

Informed consent was signed by all parents or guardians of the patients after they received detailed information about the planned clinical trial and their children's future orthodontic treatment. Beginning in 2007, consecutive patients with a comparable transversal arch dimensions Class I malocclusion in the permanent dentition were randomly assigned by one investigator (MRA) for extraction or nonextraction treatment. This sample was consecutively treated at the University of Lins, Dental School, Lins, SP, Brazil. The sample size was determined by performing a power analysis where the lower limit of the effect size ( $d=1.0$ ) produced a sample size estimate of 34 total participants (17 participants per condition) with a conventional alpha level ( $p=0.05$ ) and desired power ( $1-\beta$ ) of 0.80. Considering an attrition rate of 30-35% a final sample size of 40 subjects (20 per group) was determined.

The final sample comprised forty-one subjects (twenty non-extraction and twenty-one extraction) with dental Class I malocclusions treated with fixed orthodontic appliances. The non-extraction group was composed of ten males and ten females with an initial mean age of  $13.1 \pm 1.7$  years and mean treatment time of  $2.4 \pm 1.0$  years. The extraction group comprised of nine males and twelve females with an initial mean age of  $13.4 \pm 1.0$  years and mean treatment time of  $2.7 \pm 0.6$  years. The maxillary and mandibular crowding was  $-4.1 \pm 2.7$  and  $-3.3 \pm 2.5$ mm for the nonextraction group and  $-5.2 \pm 2.8$  and  $-5.9 \pm 3.1$ mm for the extraction group, respectively. The decision for extraction was made according to the amount of crowding ranging from 7 to 15mm in the upper and lower arches and facial profile.

1. To be included in the study the patients would have to have the following selection criteria: At the beginning of treatment, all patients included were in the permanent dentition with the presence of all first and second permanent molars.
2. All patients had dental Class I molar relationship.
3. All patients had no absence of tooth agenesis or missing permanent teeth.
4. Exclusion of subjects with craniofacial syndromes or systematic diseases.
5. All patients were treated with a preadjusted appliance (Roth prescription) with a 0.022 x 0.030-inch (3M Unitek, Monrovia, Calif.) slot. None of the patients had any adjunctive appliance [such as a Headgear, a transpalatal bar, Quad Helix, a functional appliance, or a rapid palatal expander (Haas, Hyrax)] used as part of their orthodontic treatment.
6. The patients whose treatment involved extraction had undergone four first premolar extractions as part of a comprehensive orthodontic treatment plan according to the previously sentence.

The study was designed as a comparative parallel study. Based on these inclusion and exclusion criteria the patients were randomly placed into two groups that compared two different techniques of treatment. The randomization process was performed as follows: the first patient was placed into one of the groups by the use of a coin-toss and every following patient that was recruited, was placed into every other group accordingly in order to ensure an equal number of patients were allocated to each group. The randomization process and patient assignment was done by MRA. The patients were orthodontically treated using the same sequence of archwires beginning with the 0.014, 0.016, 0.018-inch nickel-titanium archwires and 0.019 x 0.025-inch stainless steel for space closure in extraction group. According to the protocol chosen, each archwire remained for two months, and it was replaced in the previously mentioned sequence. The archwires were attached to the brackets in both groups by means of using a metallic ligature.

The intercanine and intermolar widths of the maxillary and mandibular dental arches were measured in the 82 study models with aid of a 0.01 mm precision digital caliper (Mitutoyo America, Aurora, IL). The widths of the anterior and posterior parts of the dental arches were measured at the canine and the first molar regions from the most labial aspect of the buccal surfaces of those teeth, as described by Gianelly [7] and Aksu [8]. The caliper was placed at the best estimate of a right angle to the palatal suture in the maxillary arch and to a line bisecting the incisor segment in the mandibular arch. Each distance was measured two times by the same operator, and the average of the two values was used as the final measure.

All statistic analyses were performed with aid of a commercial statistical package (SigmaSta™, Statistical Software for Windows, Version 1.0; SPSS Science, Chicago, Ill, USA). Descriptive statistics, including means and standard deviations, were calculated for each of the measures. In order to perform an evaluation of the data distribution, the data were analyzed by means of Kolmogorov-Smirnov test. Because of the normal distribution of the data, parametric tests were later used. To compare the changes between both groups, independent samples *t*-test was performed.

Twenty study models were selected randomly and re-measured by the same examiner. Random error was calculated using Dahlberg's formula (Method Error =  $(\sum d^2)/2n$ )<sup>1/2</sup> where *d* is the difference in measurements of model values on two different occasions and *n* is the number of double recordings and the paired "t" test was used for detection of systematic errors. No systematic error was found. Casual error of the measurements ranged from 0.21mm to 0.24mm.

## Results

At the start of treatment, the maxillary and the mandibular intercanine and intermolar widths of both groups did not differ statistically (Table 1). At the end of treatment, the arch widths of both groups were statistically different with one exception (Table 2). No differences were found between the groups in maxillary intercanine width for the nonextraction group ( $36.02 \pm 1.82$  mm) and for the extraction group ( $36.46 \pm 1.75$  mm) with a mean difference of 0.44 mm (Table 2). However, the average mandibular intercanine arch dimension was 1.94 mm larger in the extraction group ( $32.09 \pm 1.56$  mm) than in the nonextraction group ( $30.15 \pm 1.52$  mm) ( $P < .01$ ). The average maxillary intermolar dimension was 2.39 mm larger in the nonextraction group ( $54.15 \pm 2.68$  mm) than in the extraction

group ( $51.76 \pm 2.61$  mm) ( $P < .01$ ). Similarly, the average mandibular intermolar dimension was 1.89 mm larger in the nonextraction group ( $53.38 \pm 2.53$  mm) than in the extraction group ( $51.49 \pm 2.78$  mm) ( $P < .05$ ).

The comparison of the mean treatment changes ( $T_2-T_1$ ) for extraction and nonextraction samples is shown in Table 3. Changes in the maxillary intermolar width and mandibular intercanine and intermolar widths of both groups were statistically different. The maxillary and mandibular intermolar widths decreased significantly for the extraction group ( $-0.74 \pm 2.77$  mm and  $-1.59 \pm 1.76$  mm, respectively) compared with nonextraction ( $1.30 \pm 2.68$  mm and  $0.37 \pm 1.24$  mm, respectively) ( $P < .01$ ;  $P < .05$ ). The mandibular intercanine width increased significantly for the extraction group ( $1.48 \pm 0.88$  mm) compared with nonextraction ( $0.52 \pm 1.17$  mm) ( $P < .01$ ). However, the mean 0.77 mm increase in the maxillary intercanine dimension for the nonextraction group was not statistically significant compared to extraction group (Table 3).

	Nonextraction (n=20)		Extraction (n=21)		p	Sig
	Mean	SD	Mean	SD		
Maxillary intercanine width	34.15	2.90	35.37	2.92	0.189	NS
Maxillary intermolar width	52.85	3.88	52.50	3.33	0.760	NS
Mandibular intercanine width	29.63	1.59	30.61	1.51	0.052	NS
Mandibular intermolar width	53.01	2.52	53.08	2.84	0.929	NS

NS indicates not significant; SD, standard deviation.

\*  $P < .05$ .

**Table 1:** Comparison of Pretreatment Maxillary and Mandibular Intercanine and Intermolar Arch Widths (mm).

	Nonextraction (n=20)		Extraction (n=21)		Difference	p	Sig
	Mean	SD	Mean	SD			
Maxillary intercanine width	36.02	1.82	36.46	1.75	0.44	0.432	NS
Maxillary intermolar width	54.15	2.68	51.76	2.61	2.39	0.006	**
Mandibular intercanine width	30.15	1.52	32.09	1.56	1.94	0.000	**
Mandibular intermolar width	53.38	2.53	51.49	2.78	1.89	0.023	*

NS indicates not significant; SD, standard deviation.

\*  $P < .05$ .

\*\*  $P < .01$ .

**Table 2:** Comparison of Posttreatment Maxillary and Mandibular Intercanine and Intermolar Arch Widths (mm).

	Nonextraction (n=20)		Extraction (n=21)		Difference	p	Sig
	Mean	SD	Mean	SD			
Maxillary intercanine width	1.86	2.21	1.09	2.36	0.77	0.287	NS
Maxillary intermolar width	1.30	2.68	-0.74	2.77	1.86	0.021	*
Mandibular intercanine width	0.52	1.17	1.48	0.88	0.96	0.003	**
Mandibular intermolar width	0.37	1.24	-1.59	1.76	1.96	0.000	**

NS indicates not significant; SD, standard deviation.

\*  $P < .05$ .

\*\*  $P < .01$ .

**Table 3:** Mean changes ( $T_2-T_1$ ) in Maxillary and Mandibular Intercanine and Intermolar Arch Widths (mm).

## Discussion

The present prospective study assessed changes in arch dimensions that occurred in consecutively patients who were treated with and without extractions. To our knowledge, a few articles [7,8,14] have retrospectively addressed the arch width changes after extraction and non-extraction therapies but none prospectively. Prospective studies, in comparison to retrospective studies, are less likely to bias.

The study was designed as a comparative parallel study. Based on these inclusion and exclusion criteria the patients were randomly placed into two groups that compared two different techniques of treatment. There are controversies as regards the importance of tooth size arch length discrepancy (TSALD). While the literature believes that this factor has an influence on the decision about extractions in the treatment, some studies [7,10,14] do not consider the effects on the dental arches to be related to TSALD. As it is extremely important to consider the TSALD in treatments that involve extractions and nonextractions protocols, in our study, more crowding was observed in the group treated with extractions ( $-5.2$  mm for the maxilla and  $-5.9$  mm for the mandible) than in the group treated without extractions ( $-4.1$  mm for the maxilla and  $-3.3$  mm for the mandible).

For Spahl and Witzig [9], defenders of orthodontic treatment without extractions of the four first premolars, the sequelae expected from the treatment with extraction, resulted in very little dentition to fill the oral space during a smile. This finding was also supported by Dierkes [10]. However, the reports of the two previously mentioned authors [9,10] are considered anecdotal as they were part of clinical case reports.

Some studies [9,11,15] have reported that the narrowest arches should be found in cases treated with extractions. In contrast with all these findings, Kim and Gianelly [14] suggested that the width of both arches of the cases treated with extraction were 1 to 2 mm wider when compared with the cases treated without extraction.

Before treatment, the maxillary and the mandibular intercanine and intermolar widths of both treated groups were essentially the same. The results of the present study showed an increase of 1.09 mm in the maxillary intercanine width, which was not statistically significant, in the group treated with extractions, and 1.86 mm in the group treated without extraction. This similar increase in maxillary intercanine widths was also found in other studies [8,12,14]. One explanation may be justified by the retraction of the anterior teeth in the group treated with extractions, and by the possible expansion resulting from the leveling of the arches in the group treated without extractions. Whereas the maxillary intermolar distances increased by 1.30 mm in the group treated without extraction, in the group treated with extractions decreases 0.74 mm. The maxillary intermolar width decreased in the group treated with extractions, which could be expected because the molars are moved in the mesial direction (loss of anchorage) to a more anterior region of the arch during space closure. However, contrary results were found in other articles as well [15,16].

With regard to the mandibular arch, there was a larger increase (1.48mm) in the intercanine width in the group treated with extractions when compared with the group treated without extractions (0.52mm). This larger increase in the mandibular intercanine distance (0.96 mm) observed in the group treated with extractions is justified by the retraction of the anterior teeth to a wider region of the arch (premolar region). This result is in agreement with Gianelly [7], who also observed changes in the mandibular intercanine width, emphasizing that the

arches were approximately 1mm wider in the mandibular intercanine region after the treatment with extraction of four first premolars. However, the group included in that study was not homogenous and the distribution of malocclusions was not the same in the extraction or nonextraction groups.

Whereas the intermolar width increased 0.37 mm in the group treated without extractions, it decreases 1.59 mm in the group treated with extractions. This result is similar to those found in other studies [8,14] and can be explained by the mesialization of the molars as a result of the previously performed extraction. It should be pointed out that the greater decrease observed in the mandibular intermolar distance (-1.59mm) in comparison with the maxillary distance (-0.74mm), also found in the study of Kim and Gianelly [14], is justified by the greater anchorage loss that usually occurs in the mandibular arch in comparison to the maxillary arch to maintain the molars in an Angle's Class I relationship.

Therefore, with the data available in our study, the maxillomandibular narrowing in the intercanine region and its compromising effects on esthetics are not consequences always expected from the treatment with extractions.

## Conclusions

- 1- Treatment with extractions of 4 first-premolars provided no significant difference in maxillary intercanine width compared to nonextraction; whereas the increase in mandibular intercanine arch width was statistically significant.
- 2- In the nonextraction group, maxillary and mandibular intermolar widths increased significantly compared to extraction group.

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