ARTÍCULO DE INVESTIGACIÓN

may-ago 2024; 25(78): 2316-2321.

Long-term study of Class I and Class II premolar extraction treatment: Analysis of stability and relapse

Estudio longitudinal de tratamientos de Clase I y Clase II con extracciones de premolares: análisis de estabilidad y retención

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Abstract

Objective. The purpose of this investigation was to compare cuspid and first molar width of 90 patients treated with the standard edgewise technique. Records were evaluated from pretreatment to post treatment and from post treatment to post retention periods with a 13.74 years' interval and from post retention to pretreatment. **Methodology.** Dental casts from 26 Class I and 64 Class II patients who had 4 premolars extracted were evaluated during pretreatment, post treatment and post retention periods. Pretreatment records were taken at average ages of 13.94, post treatment records at 16.85 and post retention records at 30.49. Dental casts were digitized and measured by cast analysis, which included intercuspid and intermolar distances. **Results.** At post treatment period, minimal expansion on mandibular and maxillary cuspids was observed; maxillary and mandibular molars were constricted. All four measurements continued to decrease after the retention period. **Conclusions.** These findings suggest that long-term intercanine widths slightly decrease towards pretreatment values for both maxillary arches after 13.74 years post retention; upper and lower cuspids widths return to its near initial measurement. Furthermore, standard edgewise technique produces minimal expansion of canines which in turn is a major contributor to increase, maintain or reduce Little's Irregularity Index.

Key words: dental expansion, long-term stability, relapse.

Resumen

Objetivo. *El propósito de esta investigación fue comparar las anchuras de los caninos y primeros molares de 90 pacientes tratados con tecnología estándar edgewise. Los modelos de yeso de diagnóstico fueron evaluados de pretratamiento a postratamiento, de postratamiento a post retención con un intervalo de 13.74 años de diferencia y de post retención a pretratamiento.* ***Metodología.*** *Se evaluaron modelos de estudio vaciados en yeso de 26 pacientes Clase I y 64 pacientes Clase II en los que se realizaron extracciones de cuatro premolares, en pretratamiento, postratamiento y post retención. Los modelos de pretratamiento fueron tomados a la edad de 13.94 años en promedio, 16.85 años postratamiento y 30.49 años post retención. Las distancias entre los caninos y los molares en los modelos de estudio fueron digitalizados y medidos.* ***Resultados.*** *Se observó expansión mínima en la distancia intercanina maxilar y mandibular al analizar el periodo de postratamiento; la distancia entre los molares maxilares y mandibulares fue constreñida. Las cuatro distancias medidas continuaron decreciendo después del periodo de retención.* ***Conclusiones.*** *Estos datos sugieren que en el largo tiempo las anchuras intercaninas ligeramente decrecen hacia las anchuras medidas en el pretratamiento para ambos arcos maxilares al ser evaluados después de 13.74 años de post retención;*

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Recibido: *enero 17, 2024.* ***Aceptado:*** *febrero 13, 2024.*

las anchuras de los caninos superiores e inferiores retornan a casi su anchura inicial. El tratamiento con tecnología estándar edgewise produce mínima expansión de los caninos. Esto a su vez es un elemento importante para incrementar, reducir o mantener el Índice de Irregularidad de Little.

Palabras clave: *expansión dental, estabilidad a largo plazo, recaída.*

INTRODUCTION

Dental relapse has been a major problem for early practitioners who were faithful followers of Dr. Angle's latter school, the philosophy of ad libitum expansion, i.e. they resolved all tooth size to arch length discrepancies by increasing arch length.[1]

The use of permanent or semipermanent retention has become more popular,[2] in 2015, Bjorn Zachrisson, who had written at least seven articles in 37 years about invisible bonded permanent retainers in orthodontics, reflected sagely on the limitations of the method and the need for its selective use.[3] It has been stated[4] that there is widespread agreement regarding the need for some sort of retention. Conversely, there is also a downside to fixed retainers as they can negatively affect periodontal health, particularly in the mandibular canines. It is important to be aware of the adverse events associated with bonded retainers.[5]

Currently, nonextraction doctrines are being heavily advocated by many in the field of orthodontics. They appeal to parents, patients, and practitioners alike due to successful marketing of product/treatment systems that make it easy for dentists to straighten teeth. Some clinicians are attracted to the idea of a treatment plan[6] that involves expansion. However, this grandiose thinking is not always based on sound evidence.

Many researchers have attempted to identify dental and skeletal factors that may be predictive of long-term stability.[7] There is limited data as predictors of long-term stability could be.[8] No individual or single predictor for long-term change could be identified.[9]

Although there is currently no consensus on an orthodontist`s ability to achieve long-term stability, evidence-based treatment objectives can help achieve satisfactory results for patients. These objectives include minimal alteration of the mandibular arch form,[9] minimal expansion of the mandibular canines and molars, retraction, or at most, minimal advancement of the mandibular incisors.[1] The patient's pretreatment arch form appears to be the best guide to future arch form stability, but even with minimal treatment changes, there is no guarantee of post retention stability.[10]

Nowadays, clear aligner therapy is now widely accepted as a primary method of orthodontic treatment. It offers advantages over conventional edgewise appliances,[11] including biological, esthetic, and psychological benefits.

Therefore, the purpose of this study was to compare the width of cuspid and first molar teeth in 90 patients who were treated with standard edgewise technique (SET). The comparison was made from the pretreatment period to the post treatment period, from the post treatment period to the post retention period, with a 13.74-year interval, and from post retention to pretreatment. The research question addressed in this study was: "What is the post retention evaluation of cuspid and molar widths of 90 patients treated with SET from pretreatment to post treatment, from post treatment to post retention and from post retention to pretreatment?" The null hypothesis being tested in this study was that SET produces minimal expansion of mandibular and maxillary cuspids in a long-term longitudinal study of Class I and Class II premolar extraction treatment with SET.

MATERIAL AND METHODS

In this study there was included 90 Class I and Class II cases of the original data from 236 long-term recall study cases received by Dr. George Harris (Menominee, Michigan) and Dr. James Ferguson (Franklin, Tennessee), from the Charles H. Tweed Foundation (TF) Long Term Study (LTS). The criteria for inclusion in the study were that all subjects had pretreatment, post treatment, and post retention records. All patients were American whites. There were 26 Class I and 64 Class II, 19 males and 71 females ***(table 1)***. All subjects had pretreatment, post treatment, and follow up long-term records. All cuspids were erupted at pretreatment. They were taken at average ages of 13.94 (range 9.70-35.60 years) pretreatment records, 16.85 (range 12.3-38.9 years) post treatment records and 30.49 (range 17.6-47.73 years) post retention records, a 13.74 years' interval, Total treatment time for the sample averaged 2.16 years ***(figure 1 y table 2)***. Each subject was included in the study because of the availability of complete records. All individuals had received comprehensive orthodontic treatment and the extraction of 4 premolars as part of their treatment. Patients treated without premolar extractions or without all four cuspids erupted were not included in the sample.

Table 1. Angle's molar Class and gender.

Sex	Angle's molar Class		Total
	I	II	
Males	7 (36.8)	12 (63.2)	19 (100)
Females	19 (26.8)	52 (73.2)	71 (100)
Total	26 (28.9)	64 (71.1)	90 (100)

Records were collected from private practitioners across north America area who used SET and were members of the TF. Members were asked to submit records of cases that had a minimum of 10 years out of treatment, regardless of treatment outcome. This would allow the establishment of a broad-based sample to describe the quality of the cases and to allow members to learn from treatment failures as well as successes.

The dental casts were digitized and measured, including the intercuspid and intermolar distances, by Donna Niemczyk with guidance from George Harris and James Ferguson using DentoFacialPlanner® software (DentoFacial Planner, Toronto, Ontario, Canada).

Ideally SET patients use a nontorqued, nonangulated 0.022-in edgewise appliance and Tweed-Merrifield directional force system, which includes precision coordinated archwires along with extra oral J-hook headgears and elastic forces to correct the malocclusion. Maxillary and mandibular dental arches are leveled and aligned, followed with directional oriented cuspid distalization on a maxillary 0.017 x 0.022-in stainless steel archwire and a mandibular 0.018 x 0.025-in stainless steel archwire. A pair of working archwires are then fabricated. A 0.020 X 0.025-in maxillary and 0.019 X 0.025-in mandibular closing-loop archwires with high-pull J-hook headgears are inserted between central and lateral incisors soldered hooks, by using with 8 oz of force elastics for 10-12 hours per day. Once mandibular space is closed, mandibular anchorage is usually prepared. Patients are instructed to wear mandibular high-pull headgear on hooks attached mesial to canines to support the mandibular arch. Finally, completion of denture is the stage in which the malocclusion is detailed. Stainless steel 0.0215 x 0.028-in wires are coordinated with first-, second-, and third- order bends. Class II elastics, anterior vertical elastics, and a high-pull "J"-hook headgear to the maxillary archwire are used for approximately 3-5 months. Intraoral elastics are prescribed to be worn 24 hours a day during this treatment phase. Retention protocol includes maxillary and mandibular Hawley retainers. Retention plan is for retainers to be worn full time for a year and then nighttime for another 8 months and then, as needed basis.[12]

Description of data entry

Cast analysis protocol (conducted by the TF research group) was as it follows: occlusal surfaces of the casts were photocopied at 200% of natural size. From this photocopy, 41 anatomical landmarks were digitized ***(figure 1)***. The procedure was performed on three sets of dental casts. Landmarks were identified on the dental casts for pretreatment (T1), post treatment (T2), and post retention (T3). Dental casts photocopies were then digitized by using DentoFacial Planner® software. All the records were digitized by technician Mrs. Donna Niemczyk.

Cast analysis

The Tweed Foundation Research Committee performed a cast analysis using the landmarks just described, we selected from among those variables for the present study a total of 4: (1) maxillary intermolar width, (2) mandibular intermolar width, (3) maxillary intercanine width, (4) mandibular intercanine width. ***Figure 2*** provides listing abbreviations and definitions of the cast variables used in the study.

Statistical analysis

Statiscal analysis was carried out using SPSS version 15.0 (Statistical Package for the Social Sciences, version 15.0, SPSS, Inc., Chicago, IL). Descriptive statistics (means and standard deviations) were calculated for each variable. An independent sample t test was used; significant levels were set at 5% level (P = 0.05).

RESULTS

Descriptive statistics for changes, means and standard deviations including minimum and maximum for the changes in various dimensions are summarized in ***tables 2, 3, 4 and 5***.

This study is relevant and important because, contrary to popular nowadays studies, in which the expansion is a buzzword,[13-16] arch expansion, increasing arch-length, development therapies, is implied as if expansion was a normal byproduct of a faster, simpler orthodontic treatment; therefore, we report the present long term stability study. Moreover, to the point of this discussion, patients were treated without any mean collapse of the upper intercanine width and without resorting to routine expansion in our study ***(tables 3, 4 and 5)***. It once again proved[17,18] that treatments with minimal expansion of mandibular and maxillary cuspids, where maxillary molars suffered minimal constriction and although mandibular molars were constricted, mandibular and maxillary cuspids widths tend to go back to almost identical original arch widths ***(table 5)***. As mandibular cuspids width is responsible for Merrifield´s Total Dentition Space Analysis[19] and Little's Irregularity Index,[20] our work shows the long-term impact of SEM; it is in agreement with discernment decades ago of the alternatives to extraction, arch expansion or development, "Flaring" or bite jumping by insightful orthodontists such as Charles Tweed, P. R. Begg, Robert Strang, Hayes Nance and Calvin Case.[21]

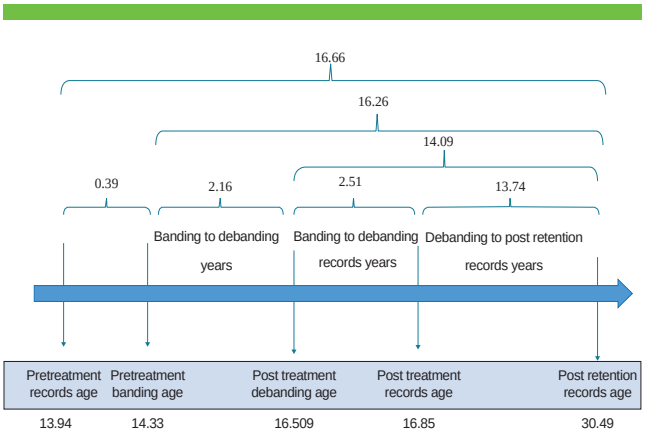

Figure 1. Mean ages at exams.

DISCUSSION

The two St. Louis University studies of all Class II, Division 1 patient's studies compared "borderline"[13] extraction to non-extraction and "clear cut" extraction to nonextraction patients 15 years post treatment and could be the "gold standard" for long term post retention studies in the existing literature. The irregularity index mean value for the four subsamples was a mean value of 3.3 mm. This value places them in the minimal irregularity (< 3.5 mm) category, and the results were achieved with patients being treated without any mean collapse of the upper intercanine width and without resorting to routine expansion; in these samples there was a satisfactory clinical result.[1]

As the two current methods to assess spacing-crowding among lower anterior teeth are the anterior space analysis of Merrifield[15] and Little's[16] irregularity index, they provide complementary information; space analysis is more attuned to tooth displacements while the irregularity index is susceptible to aversions.[17] Although our data ***(tables 3, 4 and 5)*** has not either of them, cuspid expansion is a major contributor to increase, maintain or diminish the above-mentioned measurements.

Even though statistical significantly (P = .000), lower cuspids width increased +1.21 mm ***(table 3)*** from pretreatment 24.61 mm to post treatment 25.82 mm; then from post treatment to post retention diminished -1.46 mm (P = .000) to 24.36 mm ***(table 4)***. The latter post retention width measurement 24.36 mm, was an almost identical one to pretreatment lower cuspid width 24.61 mm, a-0.25 mm difference not statistically significant (P = .439) ***(table 5)***, i. e. cuspid width goes go back to its initial measurement, this agrees with Franklin *et al*.,[9] Vaden *et al*.[21] Blake *et al*.[22] among others. As confirmed by Blake *et al*.,[22] there are some clinical considerations that are directly involved with stability. So, it is concluded that patient's pretreatment lower arch form should be maintained during

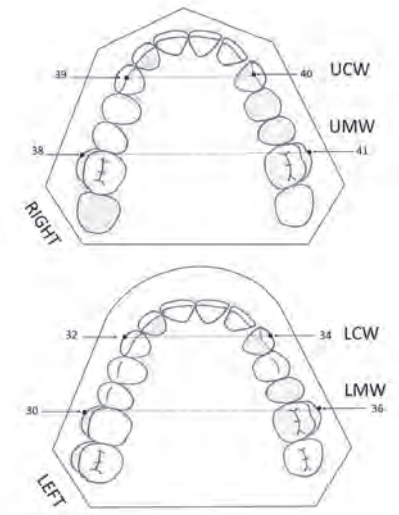

Figure 2. Image showing digitized landmarks and measurements. Digitized Landmarks. 30. Lower left molar (LL6) mesial buccal groove at gum line point. 32. Lower left cupid (LL3) cusp tip point. 34. Lower right cupid (LR3) cup tip point. 36. Lower right molar (LR6) mesial buccal groove at the gum line. 38. Upper right first molar (UR6) gum line point: intersection of the line connecting upper first molar mesial buccal cusp tip and gum line. 39. Upper right cupid (UR3) cusp tip. 40. Upper left cuspid (UL3) cusp tip. 41. Upper left first molar (UL6) gum line point: intersection of the line connecting upper left first molar mesial buccal cusp tips and gum line. **Measurements:** UMW, Maxillary Intermolar Width: The linear distance (in millimeters) from the buccal gingival margins of the upper right and left molars above the mesial buccal cusp tip. LMW, Mandibular Intermolar Width: The linear distance (in millimeters) from buccal gingival margins of the lower right and left first molars below the buccal groove. UCW, Maxillary Intercuspid Width: The linear distance (in millimeters) from the upper right canine cusp tip to the upper left canine cusp tip. LCW, Mandibular Intercuspid Width: The linear distance (in millimeters) from the lower right canine cusp tip to the lower left canine cusp tip.

Table 2. Descriptive statistics for chronologic ages at pretreatment records, banding, post treatment debanding, post treatment records and post retention records. Time elapsed (years) between pretreatment records, banding, post treatment debanding, post treatment records and post retention records.

Variables (N = 90)	Range	Min	Max	Mean	D.E
Pretreatment records-age	25.90	9.70	35.60	13.94	4.23
Banding-age	26.1	10.0	36.1	14.33	4.21
Post treatment debanding-age	26.8	12.0	38.9	16.50	4.2
Post treatment records-age	26.62	12.30	38.9	16.85	4.18
Post retention records-age	30.11	17.6	47.73	30.49	5.96
Pretreatment banding to post treatment debanding time (years)	4.06	0.83	4.88	2.16	0.60
Pretreatment records to post treatment records time (years)	3.83	1.10	4.94	2.51	0.71
Post treatment debanding to post retention records time (years)	20.5	2.5	23.0	14.09	4.61
Post treatment records to post retention records time (years)	20.05	2.54	22.59	13.74	4.64
Pretreatment records to post retention records time (years)	20.03	4.82	24.85	16.66	4.59
Pretreatment banding to post retention (years)	20.05	4.66	24.71	16.26	4.60

orthodontic treatment, and original lower intercanine width should be maintained because expansion of lower intercanine width is the most predictable of all orthodontic relapse.

In our sample, there was not any mean collapse of the upper intercanine width as treatment did not resorted to routine expansion (in agreement with Luppanapornlarp & Johnston),[18] there was a statistical significantly greater increase +1.42 mm ***(table 3)*** from pretreatment 32.57 mm to post treatment 33.99 mm width measurement; then from post treatment 33.99 decreased statistical significantly to post retention 32.72 mm, -1.27 mm ***(table 4)***. This post retention cuspid width measurement 32.72 is not statistically significant different form pretreatment upper cuspid width 32.57 mm, only +0.15 mm wider ***(table 5)***, almost identical.

Lower molars width decreased 2.81 mm (P = 0.000) from pretreatment 50.53 mm to post treatment 47.72 mm ***(table 3)***. From the latter post treatment 47.72 mm to post retention 46.68 mm ***(table 4)*** lessened another 1.04 mm (P = 0.060).

Upper molar width started with a mean of 51.03 mm at pretreatment and 50.33 mm, -0.7 mm at post treatment (P = .002) ***(table 3)***. If premolars are extracted, the upper buccal segments almost always move mesially.[19] When comparing post treatment 50.33 to post retention 49.12 mm ***(table 4)***, there was a -1.21mm difference (P = 0.046); our data shows that upper molars were not expanded during treatment. Upper molar width measurement 49.12 mm, at 13.74 years post retention, shrank 1.91 mm (P = 0.003) from pretreatment 51.03 mm ***(table 5)***, i.e., molar width r with time.

Table 3. Descriptive statistics for cuspid and molar widths at pretreatment and post treatment records expressed in mm.

Measurements	Pretreatment		Post treatment		Paired t test (*p* value)
	Mean	SD	Mean	SD	
UMW	51.03	3.125	50.33	2.526	0.002
LMW	50.53	2.562	47.72	2.162	0.000
UCW	32.57	2.203	33.99	3.524	0.001
LCW	24.61	1.976	25.82	1.496	0.000

Table 4. Descriptive statistics for cuspid and molar widths at post treatment and post retention records expressed in mm.

Measurements	Pretreatment		Post treatment		Paired t test (*p* value)
	Mean	SD	Mean	SD	
UMW	50.33	2.526	49.12	5.792	0.046
LMW	47.72	2.162	46.68	5.460	0.060
UCW	33.99	3.524	32.72	4.006	0.022
LCW	25.82	1.496	24.36	3.077	0.000

Table 5. Descriptive statistics for cuspid and molar widths at pretreatment and post retention records expressed in mm.

Measurements	Pretreatment		Post treatment		Paired t test (*p* value)
	Mean	SD	Mean	SD	
UMW	51.03	3.125	49.12	5.792	0.003
LMW	50.53	2.562	46.68	5.460	0.000
UCW	32.57	2.203	32.72	4.006	0.721
LCW	24.61	1.976	24.36	3.077	0.439

These results seem to support Strang's[20] claim that the key teeth in designating the tooth positioning that is harmonious with the muscular forces constantly in action upon the denture, are the mandibular canine and mandibular first molar dental units. The form of the maxillary denture and the positioning of the maxillary teeth are governed by the mandibular denture form and tooth positioning established by muscular balance. BeGole *et al*.[25] concluded that intercanine widths for both maxillary arches decreased toward pretreatment values, our data reports similar findings ***(table 5)***. Peck[6] concluded that natural equilibrium or homeostasis wins eventually, so that we had better work with nature, rather than dream up systems against her.

Paquette *et al*.[17] borderline extraction and nonextraction comparison, the average changes in the intermolar and intercanine dimensions post treatment were generally smaller, with the exception of 2.5 mm of net intermolar expansion in the nonextraction patients, and were consistent with the normal pattern of occlusal maturation in the untreated subjects with "clinically 'good' occlusion",[22] modified by the anteroposterior movement of the teeth into wider and narrower parts of the arch. Moreover, they state that perhaps as a result of this relative lack of canine expansion, 73% of their extraction patients and 57% of their nonextraction patients returned with less than 3.5 mm of irregularity index. Our data supports the fact that SET produces minimal expansion of canines and molars which in turn is a major contributor to increase, maintain or reduce the above-mentioned measurements.

Although this is not a randomized controlled trial, the 13.74 years post retention focus in long term stability. One notable limitation in this retrospective study is that Little Irregularity Index[16] was not measured, there is no solution for it but, we envisioned there is a lot to learn from our data.

CONCLUSIONS

Long-term intercanine widths decrease for both maxillary arches after 13.74 years post retention towards similar pretreatment values. Our data supports the fact that SET produces minimal expansion of canines and upper molar.

Furthermore, the latter in turn, is a major contributor to increase, maintain or reduce Little's Irregularity Index.[16]

Results of this study are suggested to be compared with those treated with other techniques to evaluate long term stability.

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