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Comparison of Transverse Maxillary Dental Arch Width Changes after Pre-Molar Extraction

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Abstract:

Objective: *To compare of transverse maxillary dental arch width changes after pre-molar extraction*

Materials and methods: *Two hundred and forty patients' digital models were used for pre- and post-treatment analysis. The measurements of anterior, middle, and posterior distances were taken on both sets of models. During T1 measurements, distances between the canine cusp tips, second premolar buccal cusp tips, and first molar mesiobuccal cusp tips were recorded. Furthermore, the distances (D) between the intercanine and intermolar lines, as well as the distance (D') between the interpremolar and intermolar lines, were established on the anatomic y-axis and maintained for posttreatment measurements (T2). Changes in mandibular and maxillary arch width were assessed within and between groups.*

Conclusion: *The utilization of extraction treatment mechanics did not lead to the development of narrow dental arches. However, non-extraction treatment resulted in an increase in arch width across all three measurements. Similar outcomes were observed in treatments that solely involved upper arch extraction, as compared to nonextraction treatment.*

Keywords: Buccal Cusp Trip, extraction/nonextraction, Intermolar line

INTRODUCTION:

The impact of arch form and arch width on smile esthetics has been a topic of discussion in orthodontic publications for a long time. It has been observed that widening dental arches can enhance smile attractiveness,[1] as having large buccal corridors can negatively affect smile esthetics. Therefore, it is believed that treatments that narrow the dental arches, such as premolar extraction, may result in poor smile esthetics.

However, the literature does not provide a clear connection between premolar extraction and a decrease in arch width. In a study conducted by Meyer et al., it was found that both patients treated with premolar extraction and patients treated without extraction showed increases in anterior arch width. There were no notable variances in the buccal corridor dimensions before or after treatment among the groups.[2] Likewise, Akyalcın et al. discovered no significant distinctions in maxillary arch width alterations in patients who underwent treatment with or without premolar extraction. Those treated without extraction exhibited slight increments in intercanine and intermolar measurements before and after treatment.[3] Additionally, both Gianelly[4] and Kim and Gianelly[5] documented no narrowing of the anterior region.

It has been widely documented in previous studies[6-9] that orthodontic treatment can lead to changes in the transverse dimension of intercanine and intermolar distance. These changes have the potential to impact the long-term stability of orthodontic treatment. However, it is also widely accepted that the altered intercanine and intermolar widths tend to revert back to their original sizes after the treatment.

This is supported by the findings of Burke et al., who observed that mandibular intercanine width expands during orthodontic treatment but returns to its pretreatment size after the removal of fixed appliances. [10]

Furthermore, de la Cruz et al. suggested that the pretreatment arch form is a significant predictor of orthodontic treatment success and stability.[11] Different studies have classified arch forms in various ways, with some using five categories (normal, ovoid, tapered, narrow-ovoid, and narrow-tapered)[11-13] and others using three categories (ovoid, square, and tapered). Additionally, racial variations have been observed in the ratios among these different arch forms.[14] In this retrospective study, digital measurements of orthodontic models were utilized to assess changes in arch width.[15]

The study focused on patients who underwent treatment with fixed orthodontic appliances and maintained their initial ovoid arch form throughout the treatment.[1]The changes in arch dimensions were then[2] compared between these patients and those who received treatment without extraction, those who had maxillary and mandibular first premolar extractions, and those who only had maxillary first premolar extraction.

MATERIALS AND METHODS:

This retrospective study received approval from the BMC/SPH Ethics Committee. The study utilized pre-treatment (T1) and post-treatment records (T2) of two hundred fifty patients who underwent orthodontic treatment with MBT orthodontic mechanics and bracket prescriptions. These records were selected from the orthodontic clinic archives of Ondokuz Mayıs University, Faculty of Dentistry, department of Orthodontics BMC/SPH, Quetta. The inclusion criteria for patients were as follows: no extraction treatment, maxillary first premolar extraction, or both maxillary and mandibular first premolar extraction. Patients with incomplete permanent dentition, crown anomalies, occlusal wear or dental restorations on the buccal cusps, potential for skeletal expansion in the maxillary and/or mandibular regions, and skeletal malocclusion were excluded from the study.

All patients included in the study had Class I canine relationships, well-aligned teeth, normal overjet and overbite, and excellent occlusion with good interdigitation at the end of their treatment. The patients selected for this retrospective study were either treated by the authors themselves or underwent comprehensive orthodontic treatment under the supervision of the authors. Orthodontic models before and after treatment were scanned and digitized using a three-dimensional scanner specifically designed for orthodontics (3Shape R-700 Desktop Orthodontic Scanner, Copenhagen, Denmark). An experienced orthodontist used the Orthoanalyzer software program (3Shape, Copenhagen, Denmark) to draw the maxillary and mandibular arch forms on the occlusal views of the scanned models. These digital images were then compared to the MBT treatment ovoid arch form (Ortho Form™ III 3M Unitek, Monrovia, Calif, USA) [Figure 1].

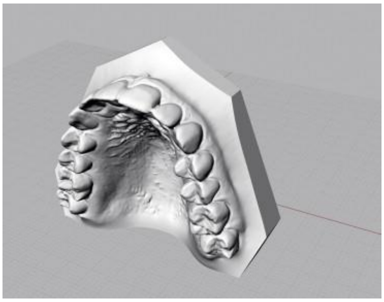

Fig: 1. The determination of arch form with software analyze

Patients who were treated with an arch form that did not match the pre-treatment ovoid arch record were excluded from the study. The patients were categorized into different groups based on their treatment plans. Group 1 consisted of 80 patients (32 boys, 48 girls) who received fixed orthodontic treatment appliances without extraction Group before the orthodontic treatment. Only maxillary posterior arch width was showed significant difference among the three groups [Table 1].

Reliability of measurement was assessed by having the same operator recalculate 20 randomly selected records 1-week after the initial measurements. Random error was calculated.

Data were analyzed using SPSS (SPSS Inc., version 22.0) for Windows. Means and standard deviations (SDs) and arch width changes (T1-T2) for each parameter (anterior, middle, and posterior) were calculated for all groups. Kolmogorov–Smirnov normality tests showed normal distributions for all three parameters for all groups. Intra group differences were evaluated using paired samples t-tests, and intergroup differences were evaluated using ANOVA with Tukey's tests. A level of $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 shows the pretreatment comparisons of anterior, middle, and posterior arch width of the groups. Only maxillary posterior and mandibular middle arch widths showed statistically difference between the Groups 1 and 3. Means and SDs of measurements at T1 and T2 are given in Table 2. In both Group 1 (nonextraction) and Group 3 (maxillary extraction), all arch width measurements increased significantly ($P < 0.05$). In Group 2 (maxillary/mandibular extraction), all mandibular arch widths, as well as maxillary posterior arch width, increased significantly following orthodontic treatment ($P < 0.05$); maxillary anterior and middle arch widths also increased, but the changes were not statistically significant ($P > 0.05$).

Changes in mandibular arch width were similar for all treatment groups; however, maxillary arch widths changes varied by group [Table 3]. Differences in maxillary anterior and middle arch width changes varied significantly between Groups 1 and 2 ($P < 0.05$), whereas the differences between Groups 1 and 3 were not statistically significance ($P > 0.05$). Changes in maxillary posterior arch width also differed significantly between Groups 1 and 3 and between Groups 2 and 3 but not between Groups 1 and Group 2 ($P > 0.05$).

DISCUSSION

A wide smile may be more appealing than a narrow one, according to Moore et al. [16,17]. They suggest that most individuals prefer minimal buccal corridors for an aesthetically pleasing smile. However, Roden-Johnson et al. [18] argue that the space of the buccal corridor does not impact smile aesthetics. The size of the buccal corridors is closely linked to the transverse dimensions of the dental arches [16,17]. As a result, several researchers have examined the effects of orthodontic treatments on the transverse dimensions of dental arches. When evaluating changes in arch width after orthodontic treatment, previous studies have primarily used the distance between the cusps of canines, premolars, and molars [19-21]. Some studies have also considered the most outward aspect of the buccal surfaces of canines and molars [4,22]. However, accurately measuring changes in arch width is challenging due to the anteroposterior movement of teeth during orthodontic treatment, particularly during space closure. Johnsons and Smiths [23] emphasize that the arch form does not simply shrink in radius like a circle when teeth are extracted. In cases where teeth are extracted during orthodontic treatment, the distance between the first molars may decrease as they move forward and inward to close the extraction spaces. Consequently, various measurement techniques have been developed to provide more precise assessments of posttreatment changes [2,3]. Akyalcın et al. [3] measured the anterior maxillary arch widths using points immediately distal to the incisive papilla and the middle maxillary arch widths using the third lateral and medial rugae on the midpalatal raphe to measure the same point on the dental arch. However, these anatomical landmarks are only applicable for maxillary measurements. In this particular study, pretreatment measurements (T1) were taken using the cusp tips. Additionally, the distances between the cusp tips of canines and molars (D) and the distance between the cusp tips of the second premolars and molars (D') at T1 were digitally measured using software.

Individual dental arches were measured at the same points in both arches. Previous studies have typically used a digital caliper to measure arch width,[23] but more recent studies have utilized software programs to evaluate arch form and calculate changes in width automatically. In this particular study, consistent results were achieved using the Orthoanalyzer software program.

However, it is important to note that this study does have some limitations. Firstly, the patient records used were retrospective, although efforts were made to select similar orthodontic models. Secondly, the patients included in the study were either treated by the authors or received orthodontic treatment under their supervision, as it was challenging to find patients treated by the same clinician.

Most studies have focused on evaluating changes in maxillary arch width following orthodontic treatment, considering the suggested relationship between maxillary arch measurements, buccal corridor ratios, and smile esthetics. However, this study aimed to assess changes in both the maxillary and mandibular arches to better understand how extraction affects the maxillary arch in comparison to the maxillary arch alone.

Isik et al. found that the post-treatment mandibular intercanine distance was wider in the extraction group compared to the nonextraction group, while mandibular interpremolar and intermolar distances decreased in the extraction group. They concluded that these decreases were a result of the consolidation of extraction spaces. The findings of this present study regarding changes in the mandibular anterior arch were similar to those of Isik et al. However, there were no significant variations in mandibular arch dimensions based on treatment modality.

Significant differences were observed in the changes of anterior maxillary arch dimensions between Group 1 and Group 3. Additionally, the increase in maxillary posterior arch width was significantly higher in Group 1 compared to Group 3. This difference could be attributed to the pretreatment posture arch width.

Hence, Group 3 exhibited a greater change in the posterior arch compared to the other groups. In the nonextraction group, we observed statistically significant differences in both maxillary and mandibular arch widths in all three measurements. These findings align with previous studies that also reported significant increases in maxillary anterior[3] and posterior arch widths[19,22] for nonextraction treatments.

However, in the extraction group, there were no significant increases in maxillary anterior and middle arch widths. Akyalcin et al. found that all arch measurements remained stable after upper and lower premolar extraction.[3] Gianelly[4] evaluated changes in anterior and posterior dental arch width after extraction and nonextraction therapy and concluded that narrow dental arches are not a consistent outcome of extraction therapy. Isik et al.[19] measured intermolar, interpremolar, and intercanine distances before and after orthodontic treatment with and without extraction. They found that while intercanine maxillary arch width was unaffected by treatment modality, increases in interpremolar and intermolar maxillary arch widths were significantly higher with nonextraction treatment compared to extraction treatment. Our study also showed a significant increase in maxillary posterior arch width in the extraction group, as well as in the nonextraction and only maxillary extraction groups. However, there are no other studies that specifically investigate the effect of only maxillary first premolar extraction treatments on arch widths. Our retrospective study demonstrated that nonextraction and only maxillary first premolar extraction cases exhibit significant increases in arch width in all three measurements when there is no skeletal malocclusion. Zachrisson[25] has highlighted crown inclination as one of the key factors in achieving an esthetic smile. Although SWA treatment utilizes a -9° torque value for maxillary molar brackets, McLaughlin et al.[26] suggest that the successful treatment of posterior teeth brackets necessitates additional torque, and it is recommended that maxillary molar brackets have a value of −14°. The MBT prescription also suggests buccal crown torques for mandibular molars and premolars. Despite variations in bracket prescriptions, this study discovered that post-treatment arch widths and changes in arch width were comparable to those reported in previous studies [2-5].

CONCLUSION

The utilization of extraction treatment mechanics did not lead to the development of narrow dental arches. However, non-extraction treatment resulted in an increase in arch width across all three measurements. Similar outcomes were observed in treatments that solely involved upper arch extraction, as compared to non-extraction treatment.

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Table No. 1: Comparison of both maxillary and mandibular arches between the groups pretreatment

	Group I-II	Group II-III	Group I-III
Maxillary anterior	Not significant	Not significant	Not significant
Maxillary middle	Not significant	Not significant	Not significant
Maxillary posterior	Not significant	0.031	0.023
Mandibular anterior	Not significant	Not significant	Not significant
Mandibular middle	0.021	0.051	Not significant
Mandibular posterior	Not significant	Not significant	Not significant

Table 2: the arch widths (mm) of the groups at T1 and T2 and differences from pre-treatment (T1) and post-treatment (T2) measurements Means and SDs.

	Group I			Group II			Group III		
	T1	T2	P	T1	T2	P	T1	T2	P
Maxillary anterior	33.92	35.11	0.000	34.22	34.44	Not Significant	33.64	34.57	0.001
Maxillary middle	44.43	46.18	0.000	43.93	44.24	Not Significant	43.44	45.18	0.003
Maxillary posterior	50.98	51.48	0.032	49.98	50.79	0.000	48.76	50.95	0.000
Mandibular anterior	26.26	26.75	0.011	26.65	27.26	0.007	26.36	26.87	0.006
Mandibular middle	39.23	40.48	0.000	37.88	38.68	0.015	38.99	40.12	0.000
Mandibular posterior	44.50	45.63	0.000	43.62	44.52	0.000	44.34	45.25	0.000

Table 3: Means and SDs of the arch width changes (mm) of the groups and comparisons between the groups

	Group I		Group II		Group III		P-value		
T2 – T1	Orthodontic	SD	Orthodontic	SD	Orthodontic	SD	Group I-II	Group I-III	Group II-III
Maxillary anterior 2-anterior 1(mm)	1.26	1.99	0.29	2.39	0.99	2.60	0.019	Not Significant	Not Significant
Maxillary middle 2- middle 1(mm)	1.80	2.58	0.62	2.78	1.86	2.15	0.003	Not Significant	0.001
Maxillary posterior 2-Posterior 1(mm)	0.61	2.19	0.91	1.61	2.31	1.89	Not Significant	0.001	0.003
Mandibular anterior 2-anterior 1(mm)	0.58	1.79	0.71	1.98	0.71	1.75	Not Significant	Not Significant	Not Significant
Mandibular middle 1 2-middle (mm)	1.63	2.69	0.91	3.48	1.25	2.45	Not Significant	Not Significant	Not Significant
Mandibular posterior1 2-posterior1 (mm)	1.20	1.99	0.98	1.79	0.99	1.29	Not Significant	Not Significant	Not Significant