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Maxillary Arch Width And Buccal Corridor Width And Area Changes In Class I Extraction Cases.

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Abstract

Aims and Objectives: To compare the pre-treatment and post-treatment maxillary arch width and buccal corridor changes in class I malocclusion treated with four premolar extraction

Methods: pretreatment and post treatment study cast models and frontal smiling photograph of 80 patients with class I malocclusion of age group of 13-30yrs (21 male ,59 female) were analyzed

Statistical analysis: Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included computation of means and standard deviations. The independent t test (for quantitative data within two groups) and paired t test (for quantitative data to compare before and after observations) were used for quantitative data comparison of all clinical indicators. Level of significance was set at $P \leq 0.05$.

Results: There were insignificant changes in the anterior arch width in relation to anterior rugae and significant increase in the posterior arch width in relation to third, lateral and medial rugae. There was no significant difference between pretreatment and post treatment buccal corridor width and area. **Conclusions**: The results indicate that the arch width is not decreased at the constant arch depth because of the extraction of premolars in class I malocclusion.

Keywords: Maxillary Arch width, Class I Extraction Cases, Buccal Corridor

Introduction

Currently, in modern orthodontics a harmonious balance between soft tissues and occlusion is taken into consideration. The former emphasis on dental and skeletal components is still valid, but greater attention to the esthetics & soft tissue aspects of orthodontics is now given.

It has been said that facial attractiveness is defined more by the smile than by soft tissue relationships.[1,2] The esthetic corner regarding a smile is often the main motivation of patients seeking orthodontic treatment.[3] In smile esthetic more emphasis is given on dental midline, smile arch, inciso-gingival display and ideal proportion of tooth. Lately, there is increased interest in effect of extraction on buccal corridor. Buccal corridor is defined as the space between the facial surfaces of the last visible posterior teeth and the corners of the lips when smiling.[4]

Various features have been postulated to affect the size of the buccal corridor, including archform[5,6] degree of smile arc[7,8] vertical facial pattern[7],anteroposterior position of the maxilla5 transverse width of the maxilla.[6,9]

Some authors have assumed that treatment via extraction of four premolars results in the development of unaesthetic and larger buccal corridors at the corners of the mouth during smiling[10- 13]

Due to the controversies on the effects of premolar extraction and its effect on buccal corridor area, the present study was undertaken to find out the correlation between premolar extraction & its effect on buccal corridor in class I malocclusion.

Material and method

Approval for this study was obtained from the Institutional Ethical Committee and Review Board of Pravara Institute of Medical Sciences. The study was conducted conducted in the Dept. of Orthodontics, Rural Dental College, Loni.

Pretreatment and post treatment study models and smiling photographs of 80 subjects of age 13 to 30 years (21 male ,59 female) with class I malocclusion who underwent four premolar extraction, each in one quadrant were included in the study. All the enrolled patients were subjected to the following eligibility criteria**:**

Inclusion Criteria

- Patients with Class I malocclusion.
- Age ranging from 13 -30 years of both the gender.
- Patients who have under gone premolar extraction in maxillary & mandibular arches
- Patients treated with the use of maxillary and mandibular fixed appliances.
- Patients in the permanent dentition without any missing permanent teeth or congenitally absent teeth with the exception of the third molars.

Exclusion Criteria

- Patients with distalization treatment.
- Patients with adjunctive expansion appliance such as a Quad Helix or palatal expander used as part of their orthodontic treatment
- Patients with self-ligating brackets

Pretreatment and post treatment posed frontal smile photographs were recorded, in a digital camera (Canon EOS 1300D,shutter speed 1/200, Aperture F 5.6, ISO 200, Flash on with flash exposure compensation of 3, Lens on 100mm magnification) with six feet distance between the subject and the camera in the same location and with the same ambient light. Photographs were taken in Frankfort horizontal plane and inter-pupillary plane parallel to the floor & in natural head position. The photographs were then transferred to a laptop in the image processing software (Autodesk AutoCAD 2016).To ensure the similarities in the pre-treatment and post-treatment photographs, first all the pre-treatment and post-treatment photographs were enlarged to fill the laptop screen, each pair of pre-treatment and post-treatment photographs were subjectively assessed to be similar, dissimilar or border line similar. For standardization of the photographs following methods were used:

a. Mesiodistal width of central incisor was measured from the respective cast and same measurement was applied to the photographic central incisor (fig 1).

b. The difference between the ratio of intercanthal width and intercommissure width was measured for pretreatment and posttreatment photographs. If the ratio difference between pretreatment and posttreatment photographs is small, then the smile at these two time points are similar (fig 2).

Figure 1: For standardization of photograph Keeping the Mesiodistal width of central incisor same

Figure 2: For standardization of photograph comparing the differences of the ratio of the intercanthal and intercommissure widths before and after treatment

All the photographic measurements were made in image processing software (Autodesk AutoCAD 2016).The liner (IC, IL, SW) and area (BCC, BCL, and TSA) were made and calculated (Table 1).

Table:1 Buccal corridor index abbreviations

Abbreviation	**Definition**
IC (intercanine distance)	The distance between the most distal surfaces of the canines.
IL (interlast visible maxillary teeth distance)	The distance between the most distal surfaces of the last visible maxillary teeth to give the width of the visible dentition.
SW (smile width)	The intercommissural width.
BCC (buccal corridor area in relation to the canines)	The bilateral area bordered by the most distal surface of each canine and the inner vermilion border of the lips.
BCL (buccal corridor area in relation to the last visible maxillary teeth)	The bilateral area bordered by the most distal surface of the last visible maxillary tooth on either side and the inner vermilion border of the lips.
TSA (total smile area)	The total area bordered by the inner vermilion border of the lips.

Fig.3.Thelinear(IC:SW)and area(BCC:TSA)measurements of a buccal corridor in relation to the canines.

Fig.4.The linear (IL: SW) and area (BCL: TSA) measurements of a Buccal corridor in relation to the last visible maxillary teeth.

Fig. 5. The linear smile width (SW) and total smile area (TSA) measurements.

Dental arch analysis

Arch widths at the levels of the maxillary canines, the most anterior premolars, and the first molars were measured at the buccal cusp tips using a electronic digital sliding caliper (Baker, Goodwill group of companies, Mumbai Indian) to the nearest 0.01 mm (Fig 1).

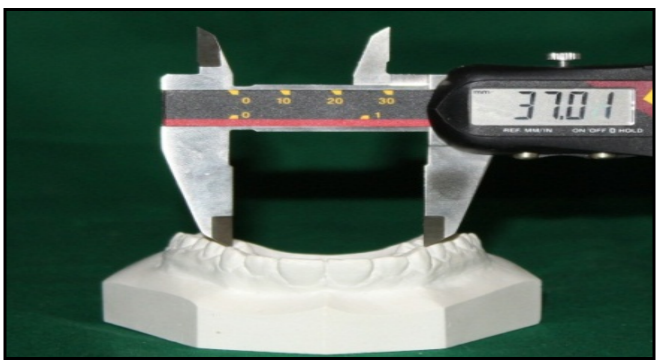

Fig 1:Arch width measurement taken from cusp tips to cusp tips of canine, premolar and first molar with digital caliper

To measure the anterior arch width, a perpendicular marking was made at the level of the point immediately distal to the incisive papilla (anterior rugae width) & then scale was kept parallel to the marking and the measurement using a digital sliding caliper (Baker, Goodwill group of companies, Mumbai Indian) was recorded (Fig 2).

To measure the posterior arch width, a perpendicular marking was made at third, lateral, and medial rugae (posterior rugae width) then the scale was kept parallel to the marking and the measurement using a digital sliding caliper (Baker, Goodwill group of companies, Mumbai Indian) was recorded (Fig 2).

Fig 2: Arch width measurement using rugae as landmark, where X is Anterior rugae width made at a point immediately distal to incisive papilla and Y is posterior rugae width made at a conjunction of third, lateral and medial rugae.

Results

The mean intercanine pretreatment and post treatment maxillary arch with was increase significantly by 1.18mm. The mean interpremolar pretreatment and post treatment maxillary arch width was significantly increase by 2.08mm. There was significant decrease in the mean intermolar width in post treatment by 1.44mm.

The was insignificant increase in mean anterior rugae width in post treatment by 0.56mm

There was significant increase in the mean post treatment posterior rugae width by 1.34mm

Table 2 : Pre Treatment And Post Treatment Maxillary Arch Width

		Mean	Std. Dev	Mean differences	P value
Intercanine	Pre	35.55	2.14	1.18	<0.001 (S)
	Post	36.73	1.52		
Interpremolar	Pre	41.98	2.73	2.08	<0.001 (S)
	Post	44.06	2.94		
Intermolar	Pre	52.22	2.85	1.44	<0.001 (S)
	Post	50.78	2.004		
Anterior rugae width	Pre	34.98	2.13	0.56	0.23
	Post	35.55	2.31		
Posterior rugae width	Pre	42.85	2.808	1.34	<0.001 (S)
	Post	44.19	2.44		

Level of significance was set at P≤0.05.

In the photographic analysis there was significant increase in the intercanine width by 1.25mm and insignificant increase in interlast visible maxillary teeth width by 0.06mm.

There was insignificant decrease in area of the Buccal corridor in relation to canine on right and left side by 2.74 and 2.51 respectively. There was insignificant decrease in the area of buccal corridor in relation to last visible tooth on in post treatment by 0.84 and 1.17 respectively

Table: 3 Pre Treatment and Post Treatment Linear Photographic Measurements

		Mean	Std. Dev	Mean differences	P value
Intercanine width	Pre	41.40	2.78	1.25	<0.001 (S)
	Post	42.65	2.93		
interlast visible maxillary teeth distance	Pre	53.69	4.82	0.06	0.98
	Post	54.63	4.51		

Table: 4 Pre Treatment and Post Treatment Buccal Corridor Area

BCC		Mean	Std. Dev	Mean differences	P value
Pre	Right	52.53	25.07	2.74	0.47
	Left	49.78	23.48		
Post	Right	51.56	24.51	2.51	0.51
	Left	49.04	23.58		
BCL					
Pre	Right	7.36	7.88	0.84	0.45
	Left	6.52	6.36		
Post	Right	8.86	7.66	1.17	0.27
	Left	7.51	5.708		

Level of significance was set at P≤0.05.

Discussion

With esthetic outcome being the foremost concern in current orthodontic practice, broad smiles and small buccal corridors have become a commonly desired treatment goal. Therefore, many clinicians have been advocating the use of nonextraction treatment. This attitude has originated from the perspective transverse arch dimensions, buccal corridors, and smile esthetics are interlinked and that tooth removal will alter the dynamics between these factors.[10,14]

However, extracting teeth, mainly the four premolars, may be necessary to position the teeth ideally in their alveolar housing because of the physiological limits of the alveolus, periodontal structures, and soft tissues.

Gianelly[15] challenged the assertion that premolar extractions narrow the dental arch by measuring the intercanine and intermolar widths in patients treated with and without premolar extractions. His findings showed that the only difference between the extraction and nonextraction groups was a slightly wider intercanine width in the nonextraction group. Kim and Gianelly[16] and Akyalcin et al.[17] confirmed that the use of fixed arch depths as a reference guide could prevent the narrowing seen in cases of extraction following orthodontic treatment. Most recently, Meyer et al.[18] reported that although arch widths increased more in their nonextraction group than in the extraction group, this did not result in any intergroup differences in the comparison of buccal corridor measurements.

In evaluating changes in arch width following orthodontic treatment, most previous studies have used the distance among cusp tips of canines, premolars, and molars,[19–21] as well as some studies, have used the most labial aspect of the buccal surfaces of canines and molars.[22,23] Due to the anteroposterior movement of teeth during orthodontic treatment, especially during space closure, it is difficult to obtain a true representation of arch width changes. As Johnsons and Smiths state, the arch form is not a circle that shrinks in radius when teeth are removed.[24]

Various measurement techniques have, thus, been developed to provide more accurate assessments of posttreatment changes.[17,18] So, Akyalcın et al. has given a method to measure the anterior maxillary arch widths using the points immediately distal to the incisive papilla and middle maxillary arch widths using the third lateral and medial rugae on the midpalatal raphe to measure the same point at the dental arch.[17] However, these anatomical landmarks are only useful for maxillary measurements.

In this study two methods were used to measure the pretreatment and posttreatment maxillary arch width.

1. By using the distance among cusp tips of canines, premolars, and molars,[19–21]
2. By using the points immediately distal to the incisive papilla for anterior maxillary arch width and using the third lateral and medial rugae on the midpalatal raphe to measure the middle maxillary arch widths.[17]

By using the first method to measure the maxillary arch width, we found out that the pretreatment maxillary arch width was narrow. Many studies have well documented that individuals who require extractions have more dental discrepancies than do those not requiring extractions.[25–27] This is partially due to the existence of a narrower dental arch base and crowded dentition that displaces the molars and premolars in a more palatal and mesial location in the patients requiring extraction.

We also found that after the extraction of premolars and space closure the maxillary intercanine width & inter premolar width was increased significantly in the post treatment by 1.18mm and 2.08mm respectively this finding are similar to the findings of other authors Devinder Preet Singh[28],Gianelly AA[22],Isik F[19],Aksu M[23]

In the study there was significant post treatment decrease in intermolar width by 1.44mm. The similar findings were found in the study conducted by Devinder Preet Singh[28], Aksu M[23]

The decrease in the distance between the first molars may occur as the first molars move forward and inward to close the extraction spaces.

However, this method does not give a true representation of arch width change at the same point in the arch because it does not account for any antero-posterior dental movements of teeth during orthodontic treatment. Despite this, same measurement method was used in this study to compare our results with the findings of previous investigations. Measurements of this nature should be taken at a constant reference point; for this reason, we also included arch width measurements using the palatal rugae. Anterior arch width, when measured at a constant arch depth in relation to rugae , there was insignificant increase in arch width by 0.56mm and the posterior arch width, when measured at a constant arch depth in relation to rugae there was significant increase in posterior arch width by 1.34mm This finding was similar to the results of Akyalcin et al.[29]who reported in his study that, all arch measurements stayed actually stable after upper and lower premolar extraction. Even this finding was similar to the study of Meyer et al.[18] in his study there was insignificant increase in anterior arch width by 0.32mm.

The second part of the study focused on the relation between the arch width and buccal corridor.

The best efforts were made to ensure that similar pre-treatment and post-treatment smiles were captured. Inter-canthal measurements have been used in diagnosis of infant orbital discrepancies, often with the canthal index. This index (ratio to inner to outer canthal distances) has the advantage of being calculable from clinical photographs alone.[30] similarly, in our study, the difficulty in retrospectively obtaining similar pretreatment & post-treatment smile photographs were overcome by using this ratio. Although there have been inconsistent reports as to the exact temporal proportion of canthal growth, it was well established that most growth in this area occurs at a young age (from 1-3 years).[30,31] The inner canthal distance was therefore deemed a suitably stable landmark for the age group of subjects assessed in this study.

Some interesting correlations were shown between measured arch width and corresponding buccal corridor widths and areas. Only post-treatment (not pretreatment) buccal corridor widths and areas in relation to the canines were found to be correlated positively with anterior arch width. This difference in pretreatment and post-treatment results might reflect a shortcoming in our method in endeavoring to measure pretreatment buccal corridor widths and areas. The canines were often ectopically displaced before treatment, especially in crowded dentitions, resulting in difficulty in measuring the distance between the distal surfaces of contralateral canines exactly parallel to the smile width. As such, several measurements of this pretreatment distance were based on a best parallel estimate. This might have given an unreliable correlation between arch width and the corresponding buccal corridor in relation to the canines.

On the other hand, the post-treatment arches were obviously aligned, so the measurements were less likely to be skewed.

At the start of treatment, the last visible maxillary teeth might also have been displaced, but not often displaced so that an accurate measurement could not be taken parallel to the total smile width. This might explain the finding that several positive pre-treatment and post-treatment correlations were found between the last visible maxillary teeth arch widths and the buccal corridor width measurements. These findings support those of Yang et al,[9] who also reported a positive correlation between arch width and the buccal corridors. This also supports the inferences of others who have linked arch width changes in their investigations to the direct effect on the buccal corridors.[17,22]

The extraction group had no significant differences between these pre-treatment and post treatment measurements. However, no statistically significant differences were found in the post-treatment values of the buccal corridor measurements, in relation to either the canines or the last visible maxillary teeth. This is consistent with the findings of **Yang et al**,[9]who also found no difference between the mean post-treatment buccal corridor areas for their extraction and non-extraction groups. So, although we determined in this study that significant arch width changes are likely to occur during treatment, the magnitude of difference would not appear to be great enough to have clinically relevant effects on buccal corridor widths and areas.

Keeping this in mind, the post-treatment buccal corridor measurements taken in relation to canine inclination suggest a relationship between them, reflecting the fact that a greater buccal inclination of the canine crowns might result in smaller buccal corridors. However, this then highlights the problem with the conventional definitions of buccal corridor. Describing the buccal corridor in relation to either the canines or the last visible maxillary teeth does not truly reflect what an observer would see as a shadow in everyday situations.

With all this, it is obvious that measuring the buccal corridor from either the canines or the last visible maxillary teeth is only a quantitative definition.

Different lighting conditions,[32–35] levels of posterior vertical gingival display,[46] variations in the tone and spatial positioning of the lips, and even the angle at which the subject is facing in relation to the viewer will all affect what is perceived to be a shadowy area at the corners of a smile.

The fact that there was much individual variation of the measurements in this study in the extraction groups is not surprising. This is because there were different amounts of crowding to resolve, and also a different amount of interarch correction was necessary in each patient. Although it is likely that the aim of treatment will be for a broader maxillary arch in short-faced patients and perhaps a narrower arch in long-faced patients, the results show that a negative effect on a person's attractiveness is unlikely simply on the basis of the decision to extract. This would support the conclusions of several previous studies that thorough diagnosis, treatment planning, and competent clinical management will lead to the best dentofacial results in orthodontic patients.[36–38]

Conclusion

Taking into account the limitations of this study and the wide individual variations of the results, the following conclusions can be drawn.

1. There was a significant difference in average post treatment maxillary anterior and posterior arch widths in patients treated with extractions.
2. Post treatment intercanine width and interpremolar width was increased in patients treated with extractions.
3. Post treatment intermolar width was decreased in patients treated with extractions.
4. Post treatment insignificant changes in the anterior arch width in relation to anterior rugae.
5. Post treatment increase in the posterior arch width in relation to third, lateral and medial rugae.
6. There was no significant difference in pretreatment and posttreatment buccal corridor width & area in extraction patients.
7. There was no negative effect of premolar extraction on maxillary arch width and buccal corridor width and area.

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