Effects of Extraction Versus Non extraction in Orthodontic treatment on Buccal Corridor Ratio (BCR)

Emad Hussein[1*], Sari Y Amer[2], Mohammad Abu Mowais[3], Nezar Watted[4], Stathis Effstathiou[5]

[1,2,3,4] Department of orthodontics, Faculty of Dentistry, Arab American University-Palestine

[5] Cyprus Orthodontic Society, Private Practice- Nicosia/ Cyprus

[1] emadhussein@rocketmail.com, [2] sariamer@hotmail.com, [3] mohammad.mowais@aaup.edu, [4] nezar.watted@aaup.edu, [5] stathis@4smileclinic.com

Abstract

Objective: *To compare the influence of dental extractions to non-extraction orthodontic treatment on smile fullness and buccal corridor ratio (BCR).*

Materials and Methods: *47 subjects from a university archive had pre- and post-treatment standardized extraoral diagnostic clinical photographs, randomly selected and distributed according to having undergone extractions (Group 1, n=24, 22 females and 2 males, mean age =20.5 ±5 years) pre-treatment, (Group 3, n=24, 22 females and 2 males, mean age =20.5 ±5 years) post treatment, or non-extraction (Group 2, n=23, 18 females and 5 males, mean age=20.9 ± 4 years) pre-treatment, (Group 4, n=23, 18 females and 5 males, mean age=20.9 ± 4 years) post treatment. Buccal Corridor Ratio (BCR) was determined for each subject, and pre/post treatment comparisons were made using T-test statistical analysis.*

Results: *Extraction group showed a lower BCR compared to non-extraction group; however, this difference was not statistically significant. On the other hand, BCR in both extraction and non-extraction treatment showed significant improvement when comparing the pre and post smile pictures in each subgroup.*

Conclusions: *Extraction treatment did not "shrink" the dental arch. It was found that dental extractions displayed a lower BCR and better smile esthetics at the end of treatment than the non- extraction group, but this difference was not significant.*

Keywords: Buccal Corridor Ratio (BCR), Smile Fullness, Smile Esthetics, Extraction Orthodontic Treatment, Non Extraction Orthodontic Treatment.

[*] Corresponding author

Introduction and Literature review

According to Peck, the aim of orthodontic treatment is to produce and maintain esthetic smiles (peck et al., 1970). Angle described an esthetic or harmonious face as requiring a full complement of teeth (Angle et al., 1900). Previously reported cephalometric studies have proposed analyses to determine dentoskeletal relationships and patterns (Broadbent et al., 1981). Commonly used cephalometric parameters focused on the hard tissues (Down et al., 1948, Steiner et al., 1953, Rickets et al., 1957).

However, Burstone stated that the soft-tissue veneer covering the teeth and skull varies so greatly that study of the dentoskeletal pattern may be inadequate in evaluating facial disharmony. He presented a direct integumental analysis employing angular readings that describe profile components to the skull as a whole and to each other (Burstone et al., 1958).

These previous efforts were all derived from sagittal plane orientations, without consideration of the frontal view. Mackley demonstrated that the profile is not a reliable predictor of the appearance of a person’s smile (Mackley et al., 1993). However, the lack of a standard objective analysis of the frontal smile has hindered research in this area. Many studies have examined the smile and its effects on perceived attractiveness, but a consistent technique for gathering smile data and analyzing them has not yet been established.

In 1999, Akerman, Proffit and Sarver described a diagnostic philosophy centered clinical examination of soft tissue function and esthetics as an emerging soft tissue paradigm in diagnosis and treatment planning. In 2005, Sabri et al. reviewed eight major components of the smile, and discussed their impact on orthodontic diagnosis and treatment planning. The principles involved in making “attractive smiles” have been coalesced into the concept of smile design. The Smile design theory is divided into four parts: facial esthetics, gingival esthetics, microesthetics and macroesthetics. (Morley et al., 2001).

The face is the key feature in the determination of human physical attractiveness (Peck et al., 1995). Facial photographic analysis can be used to determine how the lips and other perioral tissues frame the smile in different postures of speech, smiling and laughter.

A smile with minimal gingival display was considered more aesthetically pleasing than one where this is excessive. Also, this so-called smile line is gender dependent, where females express a smile line 1.5 mm higher than males, on average (Sarver et al., 2001). Furthermore, esthetic conditions related to gingival health and appearance are an essential component of effective smile design (Morley et al., 2001).

Microesthetics refers to dentally related conditions including tooth arrangement, color, shape, dimensions and proportion. However, Macroesthetics refers to the face, its harmony and proportions (Sarver et al., 2005). An area where these smile design aspects meet is the buccal corridor. This para-anatomical area has previously been described and delineated.

In 1958, Frush and Fisher derived this area by dividing the difference between the inner commissure width and visible maxillary dentition on the inner commissure width multiplied by 100. In 1970, Hulsey calculated the buccal corridor ratio by dividing the inter-canine width by the commissure width multiplied by 100. Moore *et al.* (2005) described a measure of smile fullness derived by dividing the measurement of the visible maxillary dentition by the inner commissure width multiplied by 100, and smile breadth by dividing outer commissure width by the breadth of the face at the level of the commissure multiplied by 100. Parekh et al (2006) and Martin et al (2007) both reported finding that smiles with smaller buccal corridors were found to be more attractive.

A systemic review in 2016 on laypeople's perceptions of frontal smile esthetics stated that orthodontic expansion and widening of collapsed arch form can dramatically improve the transverse smile dimension, and that lay tolerance for buccal corridor was between 5 and 16 mm, whereas the ideal buccal corridors amounts were discordant, ranging from 6 to 11.6 mm (Parrini et al., 2016).

Previous reports have not found consistent relationships as to the effects dental extractions have on smile esthetics (Parrini et al., 2016). Spahl and Witzig concluded that this leads to constricted dental arches, which, in turn, results in increased buccal corridors, and thus making the smile less aesthetic. However, several studies reported that there is no effect of dental extractions on smile esthetics or buccal corridors (Kim et al., 2003, Gianelly et al., 2003, Yang et al., 2008).

Most previous studies compared the post treatment records of extraction and non-extraction subjects without regard to pre-treatment comparison. The aim of this article is to assess whether an extraction or non-extraction orthodontic treatment choice has any effect on the Buccal Corridor as determined from pre- and post-treatment records.

Materials and methods

Orthodontic records of 200 subjects were obtained together with patient informed consent from a university archive having pre- and post-treatment standardized extraoral diagnostic clinical photographs. All patients were treated by the same orthodontist with the same 0.022”x0.028” MBT prescription Pinnacle fixed appliance from Ortho Technology USA. Patients with previous Orthodontic treatment, patients with facial asymmetry, temporo-mandibular joint disorder, cleft lip and palate, or any other syndromes, orthognathic surgery experience, missing teeth, severe crowding and cross bite were excluded from the study. All patients that were included in this study had class I skeletal malocclusion with mild to moderate crowding, age between 13 to 30 years old. After the applications of the exclusion criteria, 47 subjects were randomly selected and distributed according to having undergone four premolars extractions before treatment (Group 1, n=24, 22 females and 2 males, mean age =20.5 ±5 years), (Group 3, n=24, 22 females and 2 males, mean age =20.5 ±5 years) after treatment, or non-extraction before treatment (Group 2, n=23, 18 females and 5 males, mean age=20.9 ± 4 years), (Group 4, n=23, 18 females and 5 males, mean age=20.9 ± 4 years) after orthodontic treatment. Buccal Corridor Ratio (BCR) was determined for each subject, and pre /post treatment comparisons were made using T-test statistical analysis.

All photographs needed for treatment outcome measurements were taken using Canon EOS 650 D Canon camera, Canon macro lens EF 100 mm and a Nissin MF18 ring flash. Photographs were adjusted and standardized in a way that the inter-pupillary line becomes horizontal to the frame (in order to eliminate any measurement error due to patient head tilting), using adobe Photoshop 2020 software for Mac (version 21.1.0) (Adobe Systems, San Jose, Calif). Measurement of visible dentition and measurement of the inner commissure width were recorded using the same Adobe Photoshop 2020 software for Mac (version 21.1.0) (Adobe Systems, San Jose, Calif). Ratio calculation was considered in this study in order to minimize the errors with linear measurement. Buccal Corridor ratio was calculated according to Frush and Fisher (Fig. 1 and Fig. 2) by calculating the difference between visible maxillary dentition width (A) and inner commissure width (B), divided by the inner Commissure width (B), multiplied by 100% according to the following formula: Buccal Corridor Ratio (BCR)= ((B-A)/B) x100%.

T-test was performed to measure the pre and post effect of each orthodontic treatment modality group utilizing the BCR measures calculated for each subject. The mean and standard deviation of all the measurements for both the extraction and the non-extraction groups were calculated. The comparison between both groups was undertaken using an independent sample *t*-test with 0.05 *P*-value.

All needed statistical analyses were performed using Minitab Software for Mac (LLC, Pennsylvania, USA) version: (19.2020.1.0).

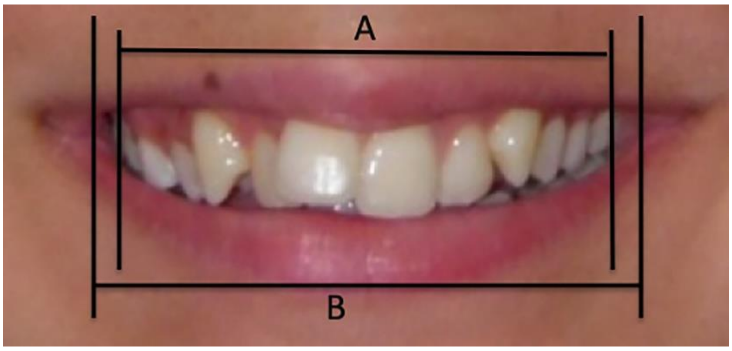

Figure 1 a: Buccal Corridor Ratio was measured in an extraction case before treatment

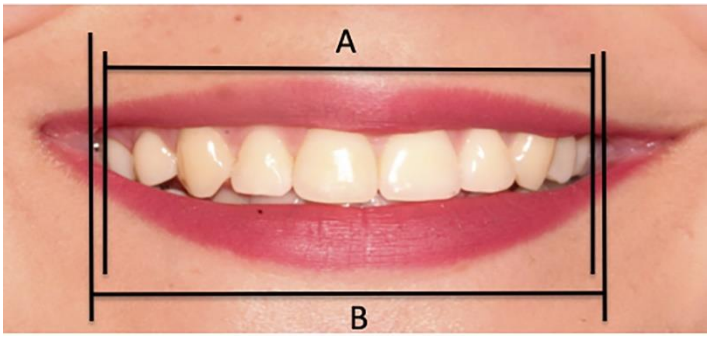

Figure 1 b: Buccal Corridor Ratio was measured in an extraction case after treatment

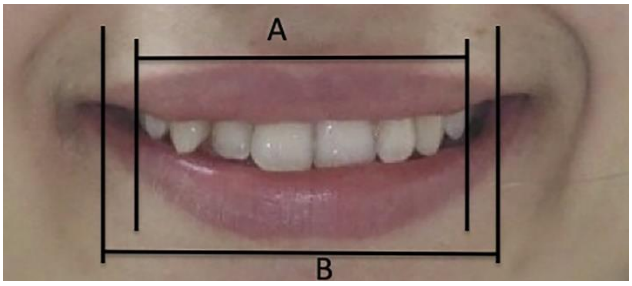

Figure 2 a: Buccal Corridor Ratio was measured in non extraction case before treatment

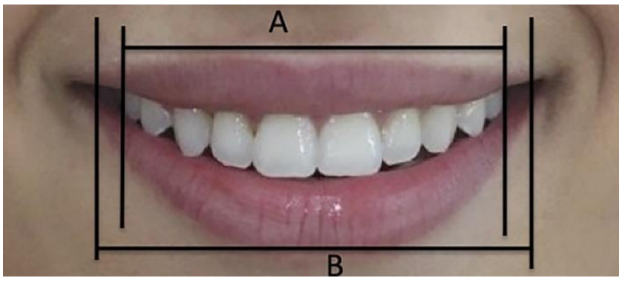

Figure 2 b : Buccal Corridor Ratio was measured in non extraction case after treatment.

Results

Buccal Corridor Ratios were measured in four categories;

Group 1: Extraction group of four premolars before treatment

Group 2: Non- extraction group before treatment

Group 3: Extraction group after treatment

Group 4: Non- extraction group after treatment

Estimation of BCR for groups 3 and 4 were performed, Buccal Corridor Ratio (BCR) in the extraction group after treatment was 11.84 ± 3.89, while the BCR in the non-extraction group after treatment was found to be 12.58 ± 2.53. The extraction group showed less buccal Corridor, but this difference was not significant since the *p* value was 0.445. (Table 1).

When BCR was compared between groups 2 and 4, it was found to be 12.58 ± 2.53 after non-extraction treatment, compared to 15.49 ± 3.76 before treatment in non-extraction, P value was 0.004 (Table 2), There was a significant reduction in the BCR after treatment in the non-extraction group .

When the BCR of groups 1 and 3. were compared, there was a reduction from 15.94 ± 4.17 in the extraction group before treatment to 11.84 ± 3.89 after treatment,and P value was 0.001. (Table 3). There was a very significant difference in BCR reduction after extraction treatment.

Table 1: Comparison of Buccal Corridor Ratio (BCR) in both extraction and non extraction After treatment; * *P*=.05.

Groups	Number of cases	BCR (mean)	Standard Deviation	*P value
After Extraction	24	11.84	3.89	
After Non Extraction	23	12.58	2.53	0.452

Table 2: Buccal Corridor Ratio (BCR) measured before and after extraction treatment, * *P*=.05.

Groups	Number of cases	BCR (Mean)	St Dev	*P Value
Before Extraction	24	15.94	4.17	
After Extraction	24	11.85	3.89	0.001

Table 3: Buccal Corridor Ratio (BCR) measured before and after non extraction treatment, * *P*=.05

Groups	Number of cases	BCR (Mean)	St Dev	*P Value
Before Non Extraction	23	15.49	3.76	
After Non Extraction	23	12.58	2.53	0.004

Discussion

Husley calculated the ratio of the inter canine distance to the distance between the corners of the mouth، but in fact the smile did not only include the 6 anterior teeth, but the first and second premolar were also and very often included. (Husley et al., 1970). In Order to measure the true buccal Corridor in extraction and non-extraction interventions, the researchers measured the ratio of visible maxillary dentition distance to the inner commissure width distance according to Frush and Fisher method. (Frush et al., 1958). In 2005, Moore et al. stated that having minimal buccal corridors was a preferred esthetic feature in both men and women, and the large buccal corridor should be included in the problem list during orthodontic diagnosis and treatment planning.

Many studies claimed that extraction could cause wide buccal corridor and would shrink the smile producing poor esthetics. However, other studies showed no effect of extraction on the buccal corridor and smile esthetics.

Our study focused on the effect of extraction and non-extraction on the buccal corridor ratio. Three comparisons were made to fully assess the differences between the extraction of and non-extraction group. First, we compared the buccal corridor ratios at the end of the treatment in both groups. Consequently, extraction groups showed less buccal spaces, but this difference was not significant. These findings do coincide with a Meta analysis article published in 2016 that concluded that there was no difference in smile esthetics and buccal corridor in both extraction and non extraction group (Cheng et al., 2016). Second, each category was tested separately to determine the effect of the treatment. Both treatment methods showed significant improvement in the buccal corridor ratios.

Moore et al. classified smile fullness into 5 categories: narrow (28% Buccal Corridor), Medium -narrow (22% buccal Corridor), Medium (15% Buccal Corridor), Medium-broad (10%), and broad (2%); most orthodontist and layperson agree that the most attractive smile is the one with less dark spaces. (Moore et al., 2005)

In this study, we found out that our interventions either with or without extraction resulted in significant improvement of BCR, and the final smile fullness was in the medium-broad range although there is stillroom for improvement. In 2019, a systematic review on the clinical effectiveness of orthodontic treatment on smile esthetics concluded that a certain type of orthodontic appliance system had a positive or negative impact on the smile arch was inconclusive, but we assume that more expanded wires and increased positive torque on posterior teeth could have resulted in further improvement and better smile esthetics (Christou et al., 2019). On the basis of this study, additional detailed and randomized control trials are needed in the area of smile esthetic and buccal corridors, and particularly the effect of different orthodontic systems and mechanics on the final smile outcome, in addition to comparing the effect on females versus males.

Conclusion

Similar BCR outcomes in patients either underwent extraction or non-extraction interventions. Both groups showed significant improvements in smile fullness at the end of the treatment. Treatment plan is not the only factor affecting smile esthetics, but treatment mechanics and appliance specification are key factors for the success in orthodontic treatment esthetic goals.

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تأثير قلع الأسنان، مقارنةً بعدم قلعها، في نسبة الممر الدهليزي (ممر الخد)

عماد حسين [1*]، ساري عامر[2]، محمد أبو مويس[3]، نزار وتد[4]، ستاثيس إفستاثيو[5]

[1,2,3,4] قسم تقويم الأسنان، كلية طب الأسنان، الجامعة العربية الأمريكية–فلسطين

[5] الجمعية القبرصية لتقويم الأسنان، عيادة خاصة – نيقوسيا/ قبرص

[1] emadhussein@rocketmail.com, [2] sariamer@hotmail.com, [3] mohammad.mowais@aaup.edu, [4] nezar.watted@aaup.edu, [5] stathis@4smileclinic.com

الملخص

الغاية: *مقارنة تأثير العلاج التقويمي بقلع الأسنان، أو عدم قلعها، في امتلاء الابتسامة، ونسبة الممر الدهليزي بين الخد والأسنان.*

الأشخاص والأساليب:

تم اختيار 47 ملفاً لمرضى من الأرشيف الجامعي، يحتوي كل ملف على صور سريرية قياسية للتشخيص خارج الفم، قبل العلاج، وبعده. وقد تم اختيار ملفات مرضى عشوائيًا، وتوزيعها وفقًا لعمليات تقويم الأسنان، مع قلع الأسنان التي خضعت لها، وقسمت لمجموعتين حسب طبيعة العلاج بالقلع: المجموعة رقم 1: وتتكون من 24 شخصا؛ 22 أنثى، وذكريين فقط، وبمتوسط للعمر= 20.5 ± 5 سنوات، قبل العلاج. والمجموعة رقم 3: وتتكون من 24 شخصا: 22 أنثى وذكريين فقط، وبمتوسط للعمر= 20.5 ± 5 سنوات، بعد العلاج. أو علاج التقويم مع عدم قلع الأسنان: المجموعة رقم 2: وتتكون من 23 شخصا: 18 أنثى و5 ذكور فقط، وبمتوسط للعمر= 20.9 ± 4 سنوات، قبل العلاج، والمجموعة رقم 4: وتتكون من 23 شخصا: 18 أنثى و5 ذكور فقط، وبمتوسط للعمر= 20.9 ± 4 سنوات، بعد العلاج. وقد تم تحديد نسبة الممر بين الخد والأسنان لكل شخص، وأجريت مقارنات قبل العلاج وبعده باستخدام التحليل الإحصائي.

النتائج:

أظهرت مجموعة العلاج بالقلع انخفاضا في نسبة ممر الخد، مقارنة بمجموعة عدم القلع، ومع ذلك، فلم يكن هذا الاختلاف مما يعتد به إحصائيًا. ومن ناحية أخرى، أظهرت نسبة ممر الخد في كل من العلاج القلعي وغير القلعي، تحسنًا ملحوظًا عند مقارنة صور الابتسامة قبل العلاج وبعده، في كل مجموعة.

الاستنتاجات:

علاج تقويم الأسنان بالقلع لم يؤد إلى تضييق قوس الأسنان، وقد وجد أن قلع الأسنان أظهر انخفاضاً في نسبة ممر الخد، وأدى إلى ابتسامة أجمل وأفضل في نهاية العلاج، من مجموعة عدم قلع الأسنان، ولكن هذا الاختلاف لم يكن ذا قيمة إحصائية معتبرة..

الكلمات الدالة: نسبة الممر الدهليزي، امتلاء الابتسامة، جمال الابتسامة.

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* الباحث المراسل