ANNALS OF DENTISTRY
University of Malaya

ORIGINAL ARTICLE

Lower Dental Arch Widths Changes Following Fixed Orthodontic Treatment

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ABSTRACT

To determine the number of cases that are at risk of poor stability in terms of arch width changes following fixed appliances treatment at the Orthodontic Unit, Klinik Pergigian Cahaya Suria, Kuala Lumpur. In a retrospective audit, 101 pre- and post-treatment lower study casts were selected from cases completed in the year 2015 at the Orthodontic Unit, Klinik Pergigian Cahaya Suria, Kuala Lumpur. Samples were measured using a universal caliper by a single calibrated operator. Samples was categorised as extraction or non-extraction types. Arch width changes was determined using paired T-test. The recommended limit was 0mm for inter-canine width, 2 mm for inter-first premolar width and 3mm for inter-second premolar and inter-molar width. Differences were considered "within limits", if the changes were within the recommended limit ±0.25mm (for possible marginal measurement error) and "expanded", if above the range for within limits. 42.6% were non-extraction while 57.4% were extraction cases. In the non-extraction group, 52.2% cases had expanded inter-canine widths, followed by inter-first and second premolars (27.9%) and inter-first molar (20.9%) widths. Arch width changes for the inter-first and second premolars and inter-molars widths were statistically significantly different ($p<0.05$) but bot clinically significant. In the extraction group, 67.2% had expanded inter-canine widths, followed by inter-first premolar (64.3%), inter-second premolar (9.1%) and inter-first molar (5.2%) widths. The inter-canine ($M=1.43$; $SD=2.71$, $p<0.05$) and inter-first premolar ($M=2.87$; $SD=2.61$, $p<0.05$) widths statistically and clinically significant expansion but the inter-second premolar and molar were significantly contracted ($p<0.05$). The number of cases with expanded arch widths was high regardless of the extraction type.

Keywords: Arch width expansion, stability

INTRODUCTION

Retention is a phase following active orthodontic treatment that aims to maintain a stable result and/or allow occlusal settling of the dentition in an ideal position. The archform and width are important features in predicting the post-treatment stability of orthodontic cases. It is generally agreed that the inter-canine distance must be maintained during treatment (1-3). The limit of expansion of the lower arch has been proposed to be up to 1-2mm for the inter-first premolar width, and up to 2-3mm for the inter-second premolar and inter-molar widths (2, 3). Post-treatment expansions which are more than these limits are associated with poor stability.

Appliances used in the retention phase are either fixed or removable. Fixed retainers are considered to be good for long term retention because it does not require compliance and are more effective compared to vacuum form retainer at maintaining mandibular labial segment alignment (4). However, such retainers require considerable maintenance because it hinders interdental cleaning. Occasionally, partially debonded fixed retainer may go unnoticed by the patient until the dentition is displaced and carries the risk of caries underneath it. Alternatively, it is easier to self-maintain oral hygiene with removable retainers such as Hawley retainers and vacuum formed retainers (VFR). VFR is popular due to its more aesthetic appearance, ease of fabrication and reduced cost compared to the Hawley retainers (5). But it is prone to discolouration, wear and tear (6-7) and has less allowance for occlusal settling (1). Hawley retainer, on the other hand, is more robust and durable (8), enables patients to chew with the appliance *in situ* (9), allows occlusal settling to improve posterior contacts (10) and is effective at holding transverse expansion (6, 7, 11). These advantages still make Hawley retainer a preferred choice among clinicians.

Since removable retainers can be removed by the patient at any time, they need to be worn for a significant duration to be effective. Currently, there is no standard regime for retention duration. Part time wear of at least 10 hours daily is as effective as full time wear in terms of overjet, arch length, intermolar width, intercanine width, and irregularity index changes at 6 months and 1-year retention period (12, 13). Nonetheless, the longer full time wear duration in the initial part of the retention phase such as for the first six months is commonly recommended, which is followed by a shorter part time or at night only wear duration of another six months (14). This is because the reorganization of the periodontal ligament and remodelling of the gingival collagen network can take up to 6 months (15). Since the elastic supracrestal fibers can remain deviated for longer periods (15), the recommended retention duration is now for indefinite period, by advising the patients to take their own responsibility to continue wearing their retainers for as long as they wish to maintain the orthodontic treatment results.

In practice, retention phases are followed up for a limited period. If little changes are observed within one or two years, patients are usually discharged. Since there is no active treatment involved during the retention phase, often there would be little need and motivation to continue appointments beyond this period as a long term effort to monitor the orthodontic treatment outcome. Following up all cases more than one or two years may also incur a need for increased manpower and resources to monitor cases in a long term. Nonetheless, there is an ethical consideration to monitor cases that has been brought beyond the limits of stability whether iatrogenic or as part of treatment plan due to case complexity. In view of this, it is prudent to determine how often this occurs in practice. Therefore, there is a need to examine cases that has completed the active phase of treatment to determine the prevalence of cases that has changed beyond the limits of stability. This may provide an insight if there is a need to recommend further action such as identifying and following up cases that has changed beyond the recommended limit to determine if the change has caused reduced stability.

The aim of this audit is to determine the prevalence of cases that are at risk of poor stability in terms of arch width changes following fixed appliances treatment. The objectives were to determine the arch widths before and after treatment, to evaluate the arch width changes by type of extraction cases and to determine the prevalence of cases that exceeded the recommended limit allowable for arch width expansion.

MATERIALS AND METHOD

Standards

We followed recommended limit for arch with changes following treatment were based on Ackerman and Profitt (1997). Clinically significant limit for expansion were:

i. Intercanine Width : 0mm
ii. Inter 1st Premolar Width : 2mm
iii. Inter 2nd Premolar Width : 3mm
iv. Intermolar width : 3mm

Since no previous study has been done, our gold standard was that differences between pre-treatment and post-treatment measurements should not exceed the recommended limit.

Sample

This retrospective audit was carried out at the Orthodontic Unit, Klinik Pergigian Cahaya Suria, Kuala Lumpur. 101 pre-treatment and post-treatment study casts was selected from completed orthodontic cases in year 2015. Both the extraction and non-extraction cases were included in this audit. This audit focused on the lower arch study casts of pre-treatment and post-treatment cases.

Parameters

The parameters measured in lower arches are as below. Measurements was made using a universal calipers (Dentaurum, Germany) to the nearest 0.1 mm.

The parameters measured were:

i. Inter-canine width

The distance between the lower right canine cusp tip to lower left canine cusp tip

ii. Inter first-premolar width

The distance between the lower right buccal cusp tip of 1st Premolar to lower left buccal cusp tip of 1st Premolar

iii. Inter second-premolar width

The distance between the lower right buccal cusp tip of 2nd Premolar to lower left buccal cusp tip of 2nd Premolar

iv. Inter first-molar width

The distance between the mesiobuccal cusp tip of lower right first molar to the mesiobuccal cusp tip of lower left first molar

Operator Reliability

The sample was assessed by a single operator. Ten non-randomly selected lower study models was obtained for operator reliability assessment. The operator measured the parameters twice, a week apart for intra-operator reliability assessment. Inter-operator reliability was compared with a second operator.

Statistical analysis

Data was analyzed using SPSS version 20 (SPSS, Chicago, III). Intra- and inter-operator reliability was determined by intra-class correlation coefficient (ICC): an ICC less than 0.4 is considered poor; between 0.4 and 0.75 as fair to good; and more than 0.75 is excellent (16).

Cases was categorised as extraction or non-extraction types. Assessment of the amount of arch width changes was determined using paired t-test since the data was normally distributed.

The differences between the pre and post treatment values was categorised as:

i. "Within limits", if the changes did not exceed the recommended limit set by the guideline and ±0.25mm to take into account of possible marginal measurement error differences

ii. "Contracted", if the changes was less than 0.25mm than the recommended lower limit set by the guideline.

iii. "Expanded", if the changes exceeded more than 0.25mm than the recommended upper limit set by the guideline.

The number of cases of the three categories was calculated to determine the current standards.

RESULTS

Intra- and inter-operator ICC were excellent at above 0.90 ($p<0.05$) (16).

101 cases were included in the audit: 43 (42.6%) were non-extraction while 58 (57.4%) were extraction cases. Of the extraction type cases, 44 were first premolar extraction and 14 were second premolar extraction cases.

Table 1 shows the arch width changes after orthodontic treatment of extraction and non-extraction cases. In the non-extraction group, arch width changes for the inter-first and second premolars and inter-molars widths were statistically significantly different ($p<0.05$) but the mean differences were not clinically significant. In the extraction group, the inter-canine ($M=1.43$; $SD=2.71$, $p<0.05$) and inter-first premolar ($M=2.87$; $SD=2.61$, $p<0.05$) widths expanded significantly, which were clinically significant, but the inter-second premolar and molar were significantly contracted ($p<0.05$).

Table 1 also shows the number of cases that were below, within and above the recommended limit allowable for arch width expansion of cases treated.

In the non-extraction group, 52.2% cases had expanded inter-canine widths, followed by inter-first and second premolars (27.9%) and inter-first molar (20.9%) widths. In the extraction group, 67.2% had expanded inter-canine widths, followed by inter-first premolar (64.3%), inter-second premolar (9.1%) and inter-first molar (5.2%) widths.

Table 1: Arch width changes based on type of cases.

Arch	N	Paired T-test					Frequency		
		Mean	S.D.	Lower	Upper	p-value	Contracted	Within Limits	Expanded
Non Extraction									
In ter-canine	43	0.02	2.18	-0.65	0.69	0.953	17 (39.5%)	4 (9.3%)	22 (52.2%)
Inter-first premolar	43	0.79	2.44	0.04	1.54	0.041*	20 (46.5%)	11 (25.6%)	12 (27.9%)
Inter-second premolar	43	1.84	2.62	1.03	2.64	0.000*	21 (48.8%)	10 (23.3%)	12 (27.9%)
Inter-first molar	43	1.07	2.36	0.35	1.80	0.005*	29 (67.4%)	5 (11.6%)	9 (20.9%)
Extraction									
Inter-canine	58	1.43	2.71	0.72	2.14	0.000*	16 (27.6%)	3 (5.2%)	39 (67.2%)
Inter-first premolar	14	2.87	2.61	1.36	4.38	0.001*	3 (21.4%)	2 (14.3%)	9 (64.3%)
Inter-second premolar	44	-1.56	3.94	-2.78	-0.39	0.011*	37 (84.1%)	3 (6.8%)	4 (9.1%)
Inter-first molar	58	-1.70	3.22	-2.54	-0.85	0.000*	51 (87.9%)	4 (6.9%)	3 (5.2%)

*p<0.05

Figure 1, on cases that were affected by expansion of the arch widths, shows that for the non-extraction group, at least 79.8% had at least one inter-arch expansion of the dentition. While for the extraction group, 82.4% had at least one inter-arch expansion of the dentition.

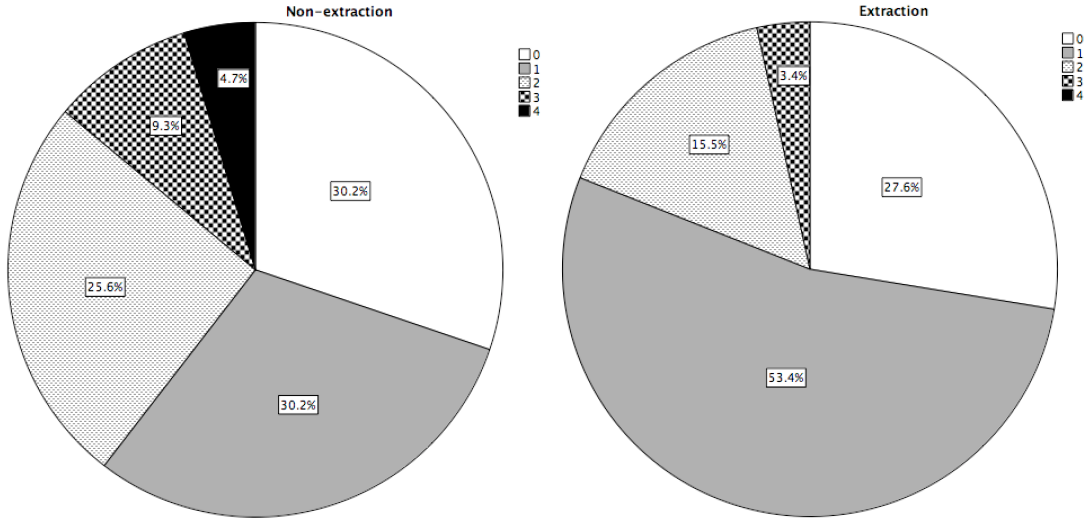

Figure 1: Pie chart showing the frequency of cases that had none inter-arch changes to those that had up to four inter-arch changes. (Label refers to the number of inter-arch changes)

DISCUSSION

This audit focused on the inter-arch widths in the lower arch because the lower arch is thought to be the foundation for the dental occlusion. Expansion of the lower arch has been thought to influence the stability of orthodontic results (2). Change in the mandibular dental arch form is significantly correlated with increased irregularity of the lower incisors (17). Thus, lower arch that has been expanded has a tendency to relapse after orthodontic treatment. Transverse expansion was more stable in the posterior region of the mandibular arch than in the anterior region (18). The degree of post retention anterior crowding is both unpredictable and variable and no pre-treatment variables either from clinical findings, casts, or cephalometric radiographs before

or after treatment seem to be useful predictors (19). The clinical guidelines by Little (1999), suggested the orthodontic treatment need to use the patient's pre-treatment arch form a guide to arch shape and avoid the enlargement of the lower arch in order to maintain the stability (19).

Cases in this audit were categorised according to the extraction approach. Extraction cases were found to be more inclined to constrict the lower arch while non-extraction cases had the tendency to expand the lower arch (20). Therefore, it was prudent to distinguish cases based on the extraction type to exclude possible confounding factor of the treatment type on the arch dimension.

In our unit, the finished cases comprised more of extraction cases compared to non-extraction cases. Several factors may have contributed to this including severity of the pre-treatment crowding, vertical dimension, lip procumbency, crowding, sagittal position of the teeth, incisor-mandibular plane angle, and midline (21) and treatment philosophy to achieve stable and satisfactory results. The decisions were made according to the need of the patients.

Our findings showed that more than half of the cases had inter-canine arch expansion, regardless of the case type. Past study found that inter-canine arch widths increased both in the extraction and non-extraction Class I patients (20). Evidence based research showed that the arch width expansion post-treatment had a strong tendency to return to its original pre-treatment arch width in both extraction and non-extraction cases (22). On hindsight, several factors may have contributed to the outcome. This includes the use of preformed archform working archwires that may be wider than the patients' original archform. Clinicians may also have overlooked to conform the working archwire with the archforms of the pre-treatment models especially in a very busy clinical setting. Consequently, this may increase the workload of the clinicians to monitor the stability the cases long term for iatrogenically increasing the arch widths.

Some philosophy supported the non-extraction treatment because they believed that the extraction treatment may cause narrowing of the dental arches simultaneously leading to unaesthetics due to the large black triangle in the buccal corridor (23). On the other hand, Gianelly (24), found that extraction treatment does not result in narrower dental arch compared to non-extraction treatment. Our finding found almost four fifths of cases, regardless of extraction type, had expanded arches. This suggest that extraction may not necessarily narrow dental arches. Both extraction and non-extraction had similar potential for expansion.

Specific features of malocclusion were not part of the selection criteria of our study. In certain cases, the lower inter-canine width can be expanded in order to correct deep overbite (25). This audit was limited to assess stability in terms of arch expansion. The stability of the alignment in the mandibular anterior teeth depends on many factors. Ormiston *et al.* (2005) concluded that male sex, greater facial growth and initial severity of malocclusions were associated with the reduced stability (26). Future studies may be recommended to include specific malocclusion, age, gender and the changes in the lower incisor position in terms of the antero-posterior relationship pre-treatment and post-treatment (27).

There are a few recommendations following our findings. We need to reinforce clinicians to be conscientious to monitor the arch widths during treatment to avoid expanding them beyond the recommended limit. Both extractions and non-extraction case types need to be mindful for monitoring as both have similar frequency for expansion. Future studies can also include investigating the influence of the stock preformed archform working archwire. The cases that had their archform expanded should also be followed up on the long term to determine the effect of expansion on the long-term treatment outcome especially on stability.

CONCLUSION

The number of cases with expanded arch widths was high regardless of the extraction type. In the non-extraction case type, the number of cases, at least 79.8% had at least one inter-arch expansion of the dentition. While for the extraction case type, 82.4% had at least one inter-arch expansion of the dentition.

ACKNOWLEDGEMENT

Director General and Principal Director of Oral Health Division, Ministry of Health Malaysia.

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