Comparing the accuracy of direct versus a new technique of indirect bracket placement- A clinical trial

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Abstract

Introduction: Aim of the study was to compare the accuracy of bracket placement between direct and new indirect bonding technique in following aspects: (a) occluso-gingival bracket position (vertical) (b) mesio-distal bracket position (horizontal), (c) Angulation of brackets.

Materials and Methods: 10 patients were bonded with split-mouth approach. For each patient, two randomly selected opposite quadrants were used as indirect bonding quadrant and the other two as direct bonding quadrant drawing 20 samples. The occluso-gingival, mesio-distal bracket position accuracy in both direct and the new indirect bonding technique were measured using digital caliper and the angulations of brackets were measured with the help of photographs and surface protractor software.

Results: results showed statistical difference between direct and a new indirect bonding technique. Proving indirect bonding is more accurate than the direct bonding of braces.

Conclusion: There is difference between mean bracket placement errors for direct and indirect methods, the range of errors in the three directions assessed were greater for direct than indirect bracket placement. The magnitudes of the findings are of clinical relevance.

Keywords: Direct bonding, Indirect bonding, Surface protractor software.

Introduction

The main aim of modern orthodontics is to create the finest occlusal relationship within the framework of acceptable facial aesthetics and stability which requires accurate positioning the crown of each individual tooth for optimum function and appearance with the advent of pre-adjusted appliance, great emphasis is being laid on accurate bracket positioning for the efficient application of biomechanics and for utilizing the full potential of this appliance.[1]

In 1972 Silverman and Cohen introduced the indirect bonding technique to place brackets on teeth more accurately and efficiently in the clinic.[3] One of the most popular technique for the indirect bonding of orthodontic brackets known as 'Thomas technique'. Instead of using the temporary medium to attach the brackets to the model, concise Orthodontic Bonding Resin was used.[5,6]

Several studies have looked at indirect bonding compared with direct bonding as it relates to bond strength. Klocke at al found that the bond strengths of light-cured composite (Transbond XT) and a chemically cured sealant (Sondhi rapid set) manufactured specifically for indirect bonding and chemically cured composite (phase II) & a chemically cured sealant (maximum cure) compared favourably with a direct bonded, light – cured control group (Transbond XT). The bond strength of a thermally cured custom base composite (Thermacure), however, was significantly lower.

The purpose of this study is to compare and evaluate the accuracy of bracket placement of direct versus indirect bonding. The goal of this study is to compare the accuracy of bracket placement between direct versus a new indirect bonding technique in following aspects: -

1. Vertical bracket position
2. Mesio-distal bracket position
3. Angulation of bracket

Material and Method

Subjects who are seeking orthodontic treatment

Materials: 20 Samples

Inclusion criteria

a) Subjects requiring upper and lower MBT™ pre-adjusted Edgewise appliances.
b) The patient's with all permanent teeth up to II molars fully erupted
c) The patient's with average teeth size and normal shape
d) The patient's with an alignment of teeth enough to permit ideal bracket placement

Exclusion criteria

a) Subjects with worn dentitions, fractured/restored cusp-tips or incisal edges, an apparent tooth size discrepancy and when anterior teeth were absent
b) where observation of the angular and mesio-distal position of
c) the brackets were obscured by crowding and
d) the patient's with retained deciduous

Methods: Ten patients requiring upper and lower MBT pre-adjusted edgewise appliances satisfying the inclusion criteria were selected for the study, each patient was subjected to a split-mouth system of

allocation of bracket bonding. The labial aspect of the dentition of each patient was divided into upper and lower segment drawing 20 sample from 10 patient. In each segment, half of the quadrant was bonded with a direct bonding technique and the other half of the quadrant was bonded by the new technique of indirect bonding randomly.

Random allocation method

Set up 1

Right upper quadrant indirectly placed	Left upper quadrant directly placed
Right lower quadrant directly placed	Left lower quadrant indirectly placed
Set up 2	
Right upper quadrant directly placed	Left upper quadrant indirectly placed
Right lower quadrant indirectly placed	Left lower quadrant directly placed

The split-mouth technique was used because each patient could act as their own control, which in turn allowed a reduction in total sample size without adversely affecting validity. In addition, the chosen method of randomization reduced variability according to patient access and co-operation.

New Indirect Bonding Techniqu

Model Preparation: The alginate impressions were obtained by using impression trays and casts were poured using dental Orthokal. In addition to a set of study models, one set of working models for each patient in the trial was obtained.

Marking Method (Fig. 1-4): The vertical facial axis of the clinical crowns was marked with 0.3 mm marking pencil on the working model by measuring the mesiodistal width of each tooth with the help of digital caliper (classic dogmatic caliper). The inciso-gingival length was measured with a digital caliper and these measurements were rounded up as the whole number nearer to it (in millimeter), in order to match with the recommended MBT bracket positioning chart.

The values obtained from the above method were recorded and reduced to half to match with the MBT bracket positioning chart. The values obtained were matched with the chart and the row most nearer to the obtained values was selected. Markings were done with the help of Height bracket positioning gauge and 0.3mm marking pencil.

Bracket Positioning and Transfer Tray Preparation Method (Fig. 4-7): 3M Unitek MBT ™ brackets were placed using bracket holder on the markings made on the working cast with the help of starch (paste of rice). The separating medium (cold mould seal) was applied on the cast; transfer tray was prepared by flowing molten glue from the glue gun and cover the brackets only partly under occlusal wings. It was left for 5 minutes so that glue gets cooled. The tray was removed with braces attached to it once the glue was set and the same is kept in water in order to remove the residues of starch attached to the bracket mesh.

Bonding (Fig. 9): The prepared transfer tray was placed in the patient's mouth and checked for any error. Then after removal of the tray, proper isolation was done by using cotton rolls and tweezer.

The etchant was applied on the labial tooth surface in the quadrant selected for indirect method.

The etchant was washed with water after 20 seconds and the tooth surface was dried primer was applied on all the dried teeth followed by application of composite on the bracket embedded in the transfer tray, the tray was then seated in the patient's mouth and curing was done for 20 seconds using light cure unit.

Measurement Technique: After direct and indirect bonding on the patient, the rubber base impression was obtained and the cast was poured using Orthokal. Photographs of each tooth were taken (Canine to Canine) in the patient's mouth by focusing on the center of each tooth using a Nikon SLR camera.

Vertical Bracket Positioning (Fig. 10): The errors in vertical bracket positioning were measured for direct and indirect bonding technique by using a digital caliper. The measurements were calculated from incisal edge of the tooth to the center of the bracket on the cast and compared with the recommended chart used for bonding of the above two techniques.

Mesio Distal Bracket Position (Fig. 11): The vertical facial axis of each tooth was drawn using a digital caliper and the line was drawn from the center of each bracket. The mesiodistal bracket positioning values were obtained by measuring the distance between the two lines i.e. vertical facial axis line of a tooth and the line drawn from the center of the bracket with the help of digital caliper.

Angulation of Bracket (Fig. 12): Photographs which were taken of each tooth in the patient's mouth by focusing on the center of the tooth were used for the measurement of angulations of brackets by using software Surface Protractor.

Fig. 1: Measuring the mesiodistal width of the crown with help of digital caliper

Fig. 2: Marking the center line on the labial surface of a tooth

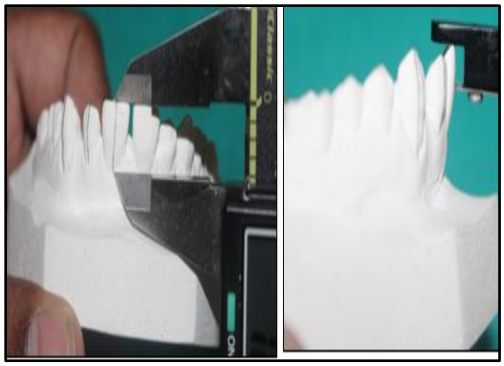

Fig. 3&4: Determining the height of the bracket slot center with HBPG

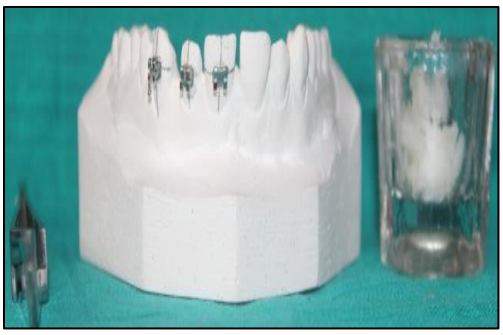

Fig. 5: Placing the bracket on working cast with help of starch (rice paste)

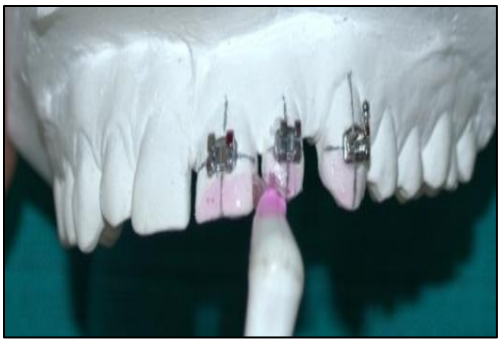

Fig. 6: Applying separating media

Fig. 7&8: Transfer tray preparation and separated from a cast with embedded brackets

Fig. 9: Bonding

Fig. 10: Measuring the occluso-gingival height of the bonded bracket

Fig. 11: Measuring mesio-distal reading of bonded bracket

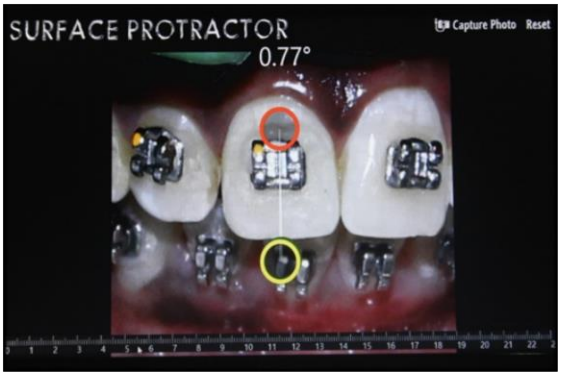

Fig. 12: Measuring angulation of bracket using surface protractor software

Results

Table 1: Comparison of central Incisor with direct & indirect bonding

Variables	Direct bonding Mean ± S.D	Indirect bonding Mean ± S.D	t-test, p-value	Significance
Occluso-gingival	0.42 ± 0.07966	0.155±0.0724	t=11.218,p<0.005	S
Mesio-distal	0.4475±0.07942	0.121±0.044	t=16.004,p<0.005	S
Angular	1.3785±0.2345	0.230±0.11480	t=19.699,p<0.002	S

Table 2: Comparison of lateral Incisor with direct & indirect bonding

Variables	Direct bonding Mean ± S.D	Indirect bonding Mean ± S.D	t-test, p-value	Significance
Occluso-gingival	0.3665 ± 0.0762	0.140 ± 0.05244	t=10.995,p<0.005	S
Mesio-distal	0.441 ± 0.11844	0.146 ± 0.06069	t=9.932,p<0.005	S
Angular	1.307 ± 0.35655	0.3275 ± 0.0840	t=3.879,p<0.001	S

Table 3: Comparison of Canine with direct & indirect bonding

Variables	Direct bonding Mean ± S.D	Indirect bonding Mean ± S.D	t-test, p-value	Significance
Occluso-gingival	0.515 ± 0.0966	0.202±0.078268	t=11.592,p<0.005	S
Mesio-distal	0.593 ± 0.1362	0.1325±0.05421	t=14.126,p<0.004	S
Angular	1.527 ± 0.38675	0.427 ± 0.09618	t=12.359,p<0.001	S

Results and Observations

Student t-test was applied between Direct and Indirect Bonding, Considering Following three parameters

1. Occluso-gingival (Vertical)
2. Mesio-distal(Horizontal)
3. Angular.

All Three Parameters were compared for direct and indirect bonding methods for each of the "Central Incisor, Lateral Incisor and Canine"

This test was performed to get the variations and or similarities between the above-mentioned groups.

Observations: In this study, all the Parameters (Vertical, Horizontal and Angular) that were Checked for direct and indirect bonding by Digital Calliper and Surface Protractor Software showed a minor significant variation in vertical and horizontal errors (in the fraction of millimetre) and comparatively more errors in angulations (around 1^{o}).

Within each group (intra-group variation)

1. Central Incisor Group: The Occluso-gingival and mesiodistal parameter showed a minor statistical significance with a p-value < 0.005 whereas the variation in the group of Angular measurements was comparatively higher with a p-value < 0.002.
2. Lateral Incisor Group: The Occluso-gingival and mesiodistal parameter showed a minor statistical significance with p-value < 0.005 whereas the variation in the group of Angular measurements was comparatively higher with p-value < 0.001.
3. Canine Group: The Occluso-gingival and mesiodistal parameter showed a minor statistical significance with a p-value < 0.005 and <0.004 respectively whereas the variation in the group of Angular measurements was comparatively higher with p-value < 0.001.

Overall, in all three groups, though there was a statistical difference, it was very minor (fraction of millimetre) a however comparatively large error was found in angular measurements (more or less 1^{0}).

Discussion

According to Anoop. Sondhi (1999)[7] Despite the clinical importance of accurate bracket placement relatively few studies have compared the accuracy of bracket placement by indirect and direct methods.

The objective of this dissertation was to compare the accuracy of two techniques of bracket placement i.e. direct and a new indirect bonding technique. The accuracy was measured in three parameters: occluso-gingival, mesio-distal and angular.

We conducted this study from canine to canine in upper and lower arch because according to T.M. Hodge.[3] (2004) aesthetic consequences of incorrect bracket positioning are more serious on anterior teeth than elsewhere in the mouth and also due to extraction of 1st or 2nd premolars in most of the cases hamper the accuracy of indirect bonding with the technique we have used in this study. According to academic protocol, 1st molars are banded. Thus we chose to conduct a study on canine to canine.

This study was conducted by a single operator, direct and indirect bonding is done in alternate quadrants in the study samples to reduce the bias in the results achieved. Armestong et al.[4] concluded that accurate direct bonding of orthodontic brackets to teeth does not appear to be related to clinical experience or specialist training.

Here in the study, we have used Height Bracket Positioning Gauge to measure the vertical height of the tooth to place the bracket. Armestong et al.[11] in another study, compared the accuracy of bracket positioning, localizing the centre of the clinical crown and measuring the distance from the incisal edge. They reported that bracket bonding guided by measuring the distance from the incisal edge may result in improved placement for anterior teeth. Mohammadi et al.[4] compared the accuracy of bracket placement with Height Bracket Positioning Gauge(HBPG) and Boone Gauge and concluded that the use of HBPG gauge results in a less vertical error and better accuracy in bracket positioning in comparison to Boon Gauge. Thus, recommended HBPG gauge. For this study, we have considered McLaughlin and Bennett proposed table to determine vertical heights of brackets.

According to Anoop Sondhi.[10] initially they used candy to position the bracket on the teeth, and chemically cured resins to bond the brackets to the teeth. This generally resulted in an excessive flash, and clean up was a significant problem. In addition, the laboratory time was excessively high. Different glues have been tried over the years, but only with moderate success. In this study, we used starch (paste of rice) to attach the bracket to the working model in indirect bonding.

Heat cured resins subsequently entered the market, but several clinicians have experienced a problem with bracket floating while heating the resin. Further, ceramic brackets could not be exposed to such heat and had to be placed separately after the metal brackets had been heat cured a cumbersome procedure. Thus we tried this new technique of attaching the bracket to the working model with the starch.

We have used a glue gun with glue to prepare a transfer tray for indirect bonding procedure. M.R. Balasubramaniam et al.[12] according to him, the development of transfer trays for indirect bonding made the use of light cured adhesives possible. The most commonly used materials for making indirect bonding trays are either silicon impression material or vacuum formed a resin. A major disadvantage of the transparent transfer trays was that it required vacuum forming equipment like the Biostar, Droformat, Drosoft etc. These equipment were expensive and the orthodontist needed to have a good laboratory support.

Larry white introduced a cost-effective indirect bonding technique using a hot glue gun for making transparent transfer trays. The hot glue matrix offered a simple, reliable and inexpensive method for transferring brackets onto the teeth accurately.

For angular measurements we have used a photographic method and then photos were selected in a surface protractor software to measure the angulations errors. According to Lahcen et al (2011)[10] the photographic assessment is a reliable way to study the position of the bracket, provided the same protocol and the same parameters are followed.

In our study comparison between the two techniques of bracket placement on Central incisor, Lateral incisor and Canine showed that the Indirect Bonding is more accurate than direct bonding in all three parameters (Table 1, 2 & 3) i.e vertical, mesio-distal and angular.

T.M. Hodge et al. (2004)[2] their results indicate that the main advantage of indirect bonding is that it reduces the envelope of error of bracket position in each of the three directions examined. For example the vertical error range for direct bonding is 1.81mm, compared with only 0.27 mm for the indirect placement.

Methodological differences make it difficult to compare the present results with those of other studies. Furthermore, it can be difficult to assess mesio-distal errors, particularly where teeth overlap, but Koo et al. felt able to do so by sectioning model teeth with a saw in an ex vivo study.

It was also interesting that they found that errors in angular placement of brackets were small and less than those either in the vertical and mesiodistal dimension. This suggests either that the various bracket design features that aid alignment is particularly effective or that the operator in the study was most accurate in this respect when placing brackets and this contrasts with previous findings, which have shown that clinicians could consistently locate the vertical facial axis of teeth, but that they were less accurate at estimating tooth angulations. Furthermore, Andrews found that operators were poor at judging angular measurements.

Bohn Chan Koo.[10] concluded that there is a difference between indirect bonding and direct bonding, with indirect bonding more accurate.

There has been disagreement in the literature regarding the accuracy of indirect bonding when compared to the standard direct technique. The present study of this dissertation shows significant statistical difference between direct and indirect bonding, proving indirect bonding is more accurate than direct bonding in all three parameters. Though the errors are in fraction of a millimetre in vertical and mesiodistal and angulations errors are by one degree.

Conclusion

1. There was a difference between mean bracket placement errors for direct and indirect methods.
2. Indirect bonding is more accurate than direct bonding in following aspects: vertical, horizontal and in angulation.
3. The magnitudes of the findings are of clinical relevance.

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