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A Comparative Evaluation of Accuracy of Bracket Placement Using Direct and Indirect Bonding Technique

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Abstract:

Introduction: *Orthodontics has advanced significantly from ancient practices, with modern techniques like Edward Angle's edgewise appliance and Lawrence Andrews' straight wire method emphasizing precise bracket placement. Direct and indirect bonding are key for accurate positioning, each with distinct advantages and limitations.*

Objectives: *This study compares bracket positioning accuracy between direct and indirect bonding, evaluating vertical, horizontal, and angular variations to determine which technique offers superior precision.*

Method: *Forty orthodontic patients at Inderprastha Dental College were randomly assigned to direct or indirect bonding groups. Following oral prophylaxis, brackets were bonded per MBT guidelines. Standardized images were captured using a Canon camera. Data were analyzed via SPSS 26, employing descriptive statistics and the Kruskal–Wallis test ($p < 0.05$).*

Results: *Both techniques showed minimal, statistically insignificant deviations ($p > 0.05$). Direct bonding exhibited consistent angular, horizontal, and vertical placement, while indirect bonding demonstrated uniformity with negligible errors, confirming both as reliable.*

Discussion: *Direct bonding had greater angular deviations due to visibility and manual positioning challenges, whereas indirect bonding's transfer trays improved consistency. Mesiodistal deviations were minor, possibly due to 2D image measurements. While no significant difference was found, indirect bonding had a narrower error range, aligning with prior studies highlighting difficulties in aligning brackets along the tooth's long axis. Both methods require refinement to enhance precision further.*

Keywords: *Bicuspid, Dentalcare, Humans, Incisor, Manipulation, Orthodontic Appliances, Orthopaedic.*

INTRODUCTION:

The field of orthodontics is not a modern development; it has a long-standing history as a specialized area of study. The earliest documented practices of teeth straightening date back to 25 BC, when individuals were advised to use their fingers to apply steady pressure on misaligned teeth to improve their positioning.[1]The shift from banding to bonding in orthodontics encouraged researchers to focus on enhancing bonding quality, as achieving precise bracket placement became a critical aspect of orthodontic treatment, as TM Graber puts it "the best results in the present and in the future will be achieved by those orthodontists who are best at accurate bracket positioning"[2,3] Accurate bracket positioning is a critical step in orthodontics, significantly influencing treatment outcomes, particularly in complex cases[1]. Clinically, brackets can be placed directly using instruments or indirectly with transfer trays. Precise placement is especially vital for pre-adjusted appliances, as even minor misalignments can lead to undesirable tooth movements, including rotation, tipping, in/out deviations, extrusion/intrusion, and torque errors[4].

The direct bonding technique was initially described by Newman in 1965, whereas Silverman et al.[5] introduced the first indirect bonding technique in 1972. Numerous and various methods evolved from these two foundational concepts, aiming to enhance the speed and precision of the bonding process [5]. This 'direct bonding technique' remove the need for a band placed between the bracket base and the surface of the tooth, the intended force could be applied directly. As newer composites with enhanced properties were introduced, the indirect bonding technique gained popularity. It has the advantage of being simple and cost-effective, as it does not require specialized equipment or laboratory assistance. However, its drawbacks include increased chairside time and challenges in accessing and positioning brackets, particularly on posterior teeth, due to limited visibility.Since Silverman et al[5]. first described an indirect bonding method in 1972,its popularity has grown due to notable benefits and some significant advantages such as unimpaired visibility during bracket positioning, including enhanced patient comfort, and reduced chairside time.[6] The indirect bonding method is frequently regarded as offering greater accuracy in bracket placement because it removes many of the practical challenges associated with the direct method, such as managing moisture in the oral environment, ensuring patient cooperation, and working within limited time constraints.[7] By allowing brackets to be positioned on study models in a controlled setting, indirect bonding provides enhanced visibility and the opportunity for meticulous adjustment. However, despite these advantages, there is still ongoing debate about whether this method consistently achieves higher placement accuracy in real-world clinical scenarios compared to direct bonding. Factors such as potential errors during the transfer process or variations in tray fabrication may influence the final outcome, leaving the question of superior accuracy unresolved.As both direct and indirect bonding techniques offer their own unique benefits and drawbacks, as reported by studies which were previously conducted by Koo BC et al[8], Deahl ST et al[9], Huang XH et al[10] and Aguirre MJ et al[4] there is a necessity to determine the most appropriate bonding method for accurate bracket placement. To date, limited research has thoroughly explored the most effective bonding technique, leaving significant gaps in understanding. This study aims to resolve this issue by assessing and comparing the precision of bracket placement using direct and indirect bonding techniques. By analysing the precision of each technique, it seeks to provide clearer insights into which method offers superior clinical outcomes, ultimately guiding orthodontists in selecting the most reliable approach for optimal treatment results.

METHODS:

A randomized clinical trial for a total of 40 patients in need of fixed orthodontic therapy in the Department of Orthodontics and Dentofacial Orthopaedics, Inderprastha Dental College and Hospital, Ghaziabad, were selected for the study based on predetermined inclusion and exclusion criteria. Patients were informed about the study, its benefits and risk. Informed consent according to institutional guideline were signed by the selected patients approval from the college ethical committee was obtained The participants were randomly assigned in two different groups based on the bonding technique.

Group A	Direct bonding technique
Group B	Indirect bonding technique

Oral prophylaxis was done ahead to the bonding process, and pumice slurry was used to polish the tooth surface. Using Boon's measure and marking pencil, teeth were reference marked horizontally and vertically in accordance with MBT's prescription[11]. In Group A and Group B individuals, brackets were bonded in accordance with the prearranged protocol. After bonding, pictures were taken with a Canon digital camera that and a 15–45 mm, lens offering 1:1 magnification. A jig was created using a rectangular wire (19 x 25 inches) (fig:3) placed at a fixed distance of 150 mm to ensure consistent imaging.

The data analysis was performed by clinical reading and data obtained were analysed using the SPSS (statistical package for social sciences) version 26 software, maintaining a significance level of 5%. Descriptive statistics mean and standard deviation were calculated. Kruskal–Walli's test was conducted for the observation and analysis of the study.

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Figure 1: Transfer tray

Figure 2: Placement of transfer tray after tooth preparation

Figure 3: Camera with jig

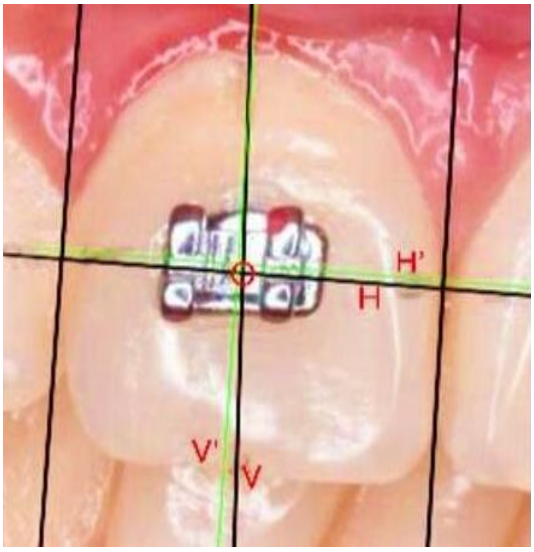


Figure 4: Reference lining on photograph

RESULTS:

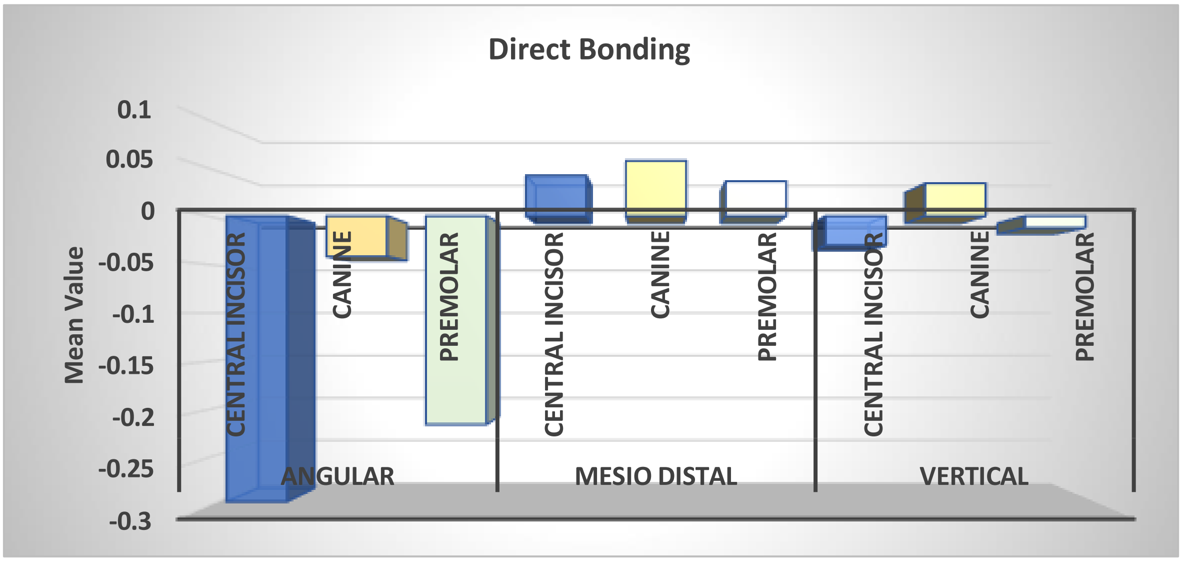
In this study, the vertical and mesiodistal positions, as well as the angulations of brackets, were evaluated and compared between direct and indirect bracket placement techniques. The extent and direction of deviations in these three parameters were recorded. Deviations were labelled as negative (–ve) if they moved toward the distal side, rotated clockwise, or shifted toward the incisal edge. On the other hand, deviations were marked as positive (+ve) if they moved toward the mesial side, rotated counterclockwise, or shifted toward the gingival margin.

Table 1: **Intragroup comparison of variation in vertical, horizontal and angular positioning of bracket in direct bonding techniques**.

VARIABLES		Mean	Std. Deviation	Chi square value	p-values/NS
ANGULAR	**CENTRAL INCISOR**	-0.295	2.735	0.107	0.776,NS
	CANINE	-0.042	2.986		
	PREMOLAR	-0.215	3.129		
MESIO DISTAL	**CENTRAL INCISOR**	0.042	0.219	0.197	0.906,NS
	CANINE	0.057	0.237		
	PREMOLAR	0.036	0.258		
VERTICAL	**CENTRAL INCISOR**	-0.03	0.253	0.898	0.638,NS
	CANINE	0.034	0.259		
	PREMOLAR	-0.012	0.257		

$p \leq 0.05$ – Significant, CI = 95 %

Graph 1: Intragroup comparison of variation in vertical, horizontal and angular positioning of bracket in direct bonding techniques



Intragroup analysis of central incisor, canine, and premolar showed no statistically significant differences in angular, horizontal, or vertical deviations for the direct bonding technique. Mean angular deviations were minimal across all teeth, with an overall p-value of 0.776. Horizontal and vertical placements also showed consistency, with p-values of 0.197 and 0.638, respectively. This indicates uniform bracket placement across tooth types using direct bonding.

Table 2: **Intragroup comparison of variation in vertical, horizontal and angular positioning of bracket in indirect bonding techniques.**

VARIABLES		Mean	Std. Deviation	Chi square value	p-values/NS
ANGULAR	**CENTRAL INCISOR**	-0.117	2.718	0.830	0.660,NS
	CANINE	0.290	2.635		
	PREMOLAR	-0.097	2.021		
MESIO DISTAL	**CENTRAL INCISOR**	0.001	0.248	0.615	0.735,NS
	CANINE	-0.011	0.265		
	PREMOLAR	-0.015	0.214		
VERTICAL	**CENTRAL INCISOR**	0.024	0.225	0.330	0.848,NS
	CANINE	0.009	0.271		
	PREMOLAR	-0.01	0.229		

$p \leq 0.05$ – Significant, CI = 95

Graph 2: Intragroup comparison of variation in vertical, horizontal and angular positioning of bracket in indirect bonding techniques.

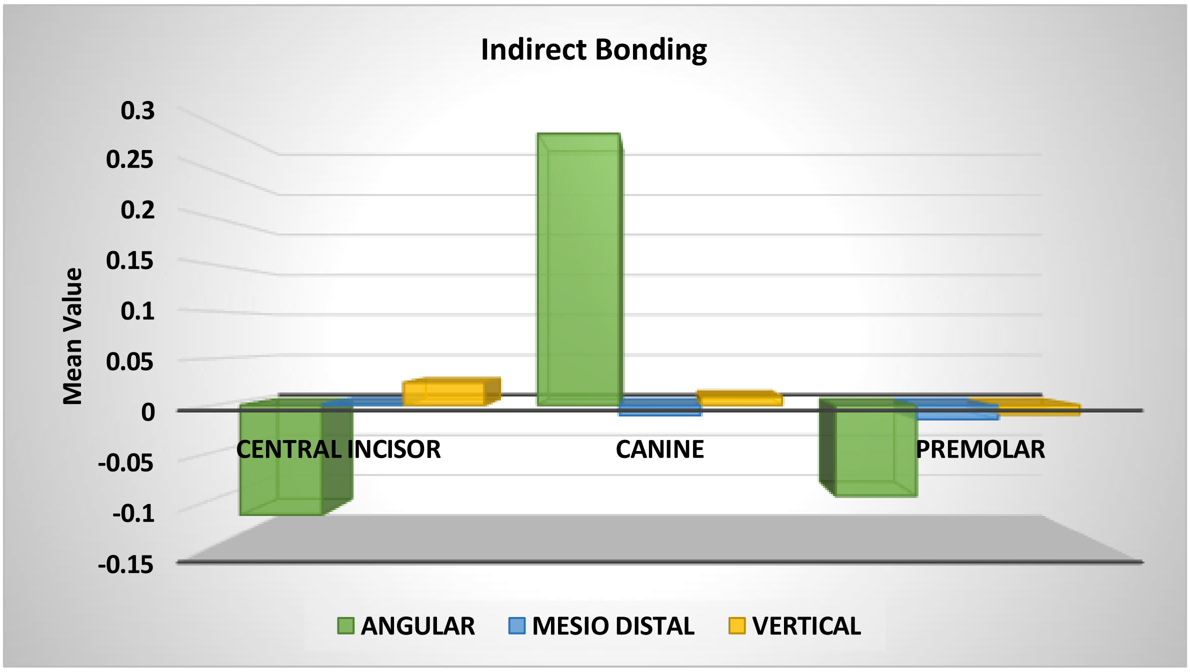


Table 2 showed no statistically significant differences in angular, horizontal, or vertical deviations for indirect bonding across central incisor, canine, and premolar. Mean deviations were minimal in all directions, with p-values of 0.660 (angular), and 0.848 (vertical), indicating consistent and reliable bracket placement using the indirect bonding technique.

Table 3: Comparison between the variation in vertical positioning, horizontal positioning and angular positioning of direct and indirect bonding techniques.

VARIABLES		DIRECT BONDING		INDIRECT BONDING		p-values/NS
		Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
CENTRAL INCISOR	**ANGULAR**	-0.295	2.735	-0.117	2.718	0.525,NS
	MESIO DISTAL	0.042	0.219	0.001	0.248	0.756,NS
	VERTICAL	-0.03	0.253	0.024	0.225	0.448,NS
CANINE	**ANGULAR**	-0.042	2.986	0.290	2.635	0.525,NS
	MESIO DISTAL	0.057	0.237	-0.011	0.265	0.203,NS
	VERTICAL	0.034	0.259	0.009	0.271	0.655,NS
PREMOLAR	**ANGULAR**	-0.215	3.129	-0.097	2.021	0.882,NS
	MESIO DISTAL	0.036	0.258	-0.015	0.214	0.336,NS
	VERTICAL	-0.012	0.257	-0.01	0.229	0.892,NS

$p \leq 0.05$ – Significant, CI = 95 %

Graph:3 Comparison between the variation in vertical positioning, horizontal positioning and angular positioning of direct and indirect bonding techniques.

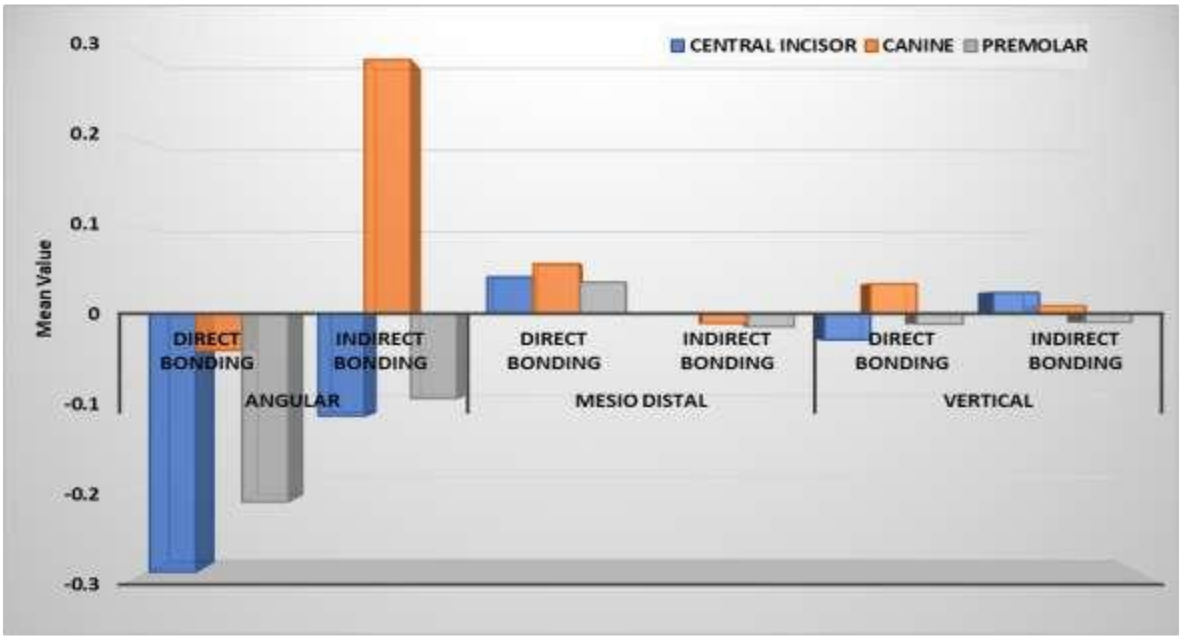


Table 3 compares direct bonding and indirect bonding techniques for the central incisor, canine, and premolar across angular, mesio-distal (horizontal), and vertical positioning. The mean values and standard deviations showed minimal deviation which resulted in non-significant difference ($p > 0.05$) between the two techniques. This suggested that both techniques provide comparable precision in bracket placement across the tested parameters.

DISCUSSION:

This research investigated whether indirect bonding offers greater accuracy in bracket placement compared to direct bonding. clinicians often encounter challenges in achieving precise bracket placement due to limited visibility, moisture control issues, and the manual dexterity required for freehand positioning. To address these limitations, indirect bonding has emerged as an alternative approach. This technique utilizes custom-designed transfer trays, which theoretically enable more controlled and accurate bracket placement. The findings of this study demonstrate a considerable magnitude of divergence in the vertical and angular positioning of brackets when comparing direct and indirect bonding methods, with angular positioning showing the most significant deviations. Although both methods exhibited greater deviations in angular positioning compared to other determinants, the direct bonding method displayed a more significant inconsistency. Accordingly, Armstrong D,Shen et al[12] suggested the same finding and linked its attribution to the extended incisor-gingival plane of the tooth, which may complicate accurate bracket placement. Mesiodistal deviations were relatively smaller across all samples. This reduction in deviation might be due to the fact that mesiodistal measurements were derived from two-dimensional images, which represent a smaller surface area compared to the actual three-dimensional curved surface of the tooth.In terms of angulation, while the discrepancy between direct and indirect bonding methods was not statistically significant, a wider range of deviation was observed compared to vertical and mesiodistal positioning for both methods. For instance, in the central incisor, the direct method showed an angulation deviation of -0.295º with a standard deviation of 2.735º, whereas the vertical positioning deviation was only -0.03 mm with a standard deviation of 0.253 mm. Similar findings were observed in the study done by Kumar J et al.[13] where it suggested that accurately assessing the long axis of the tooth in a clinical setting is challenging.

Overall, no statistical significance was observed between direct and indirect bonding, with brackets placement.

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