ABSTRACT:
Indirect bonding has been an exciting advancement in orthodontics over the last ten years. It is of great benefit to the clinician as it improves patient comfort, reduces chair time, and improves the accuracy of bracket placement. It has been widely recognized for many years that accurate bracket positioning is of critical importance in the efficient application of biomechanics and in realizing the full potential of a preadjusted edgewise appliance. There are so many steps and applications in indirect bonding, so all these are opened for modification. There were doubts about bond failures but studies showed that there is no significant difference between direct and indirect technique on bond strength.

INTRODUCTION:
Several techniques for indirect bonding are available. In some, the brackets are glued with a temporary material to the teeth on the patient’s model transferred to the mouth with some sort of tray into which the brackets become incorporated, and then bonded simultaneously with a bis-GMA resin. However, most current indirect bonding techniques attach the brackets with composite resin to form a custom base. A transfer tray of silicone putty or thermoplastic material is used, and the custom bracket bases are then bonded to the teeth with chemically cured sealant.\(^1\)

History:
Indirect bonding was first described in detail by Silverman and Cohen in 1972, they used cements for bonding brackets onto working models and prepared a thermoplastic transfer tray. In following years, they developed this technique by using different resins (methymetacrylate, Nuva-Fil bis-GMA etc.), and in 1975, they prolonged chair time by using light cured adhesive.\(^2,3\) At the beginning of 1980s, thermally cured adhesives were introduced. The working models with brackets attached were heated to 250-300 °F for approximately 15 to 20 minutes as a means of curing the resin. But, in this procedure, brackets were drifting from ideal places and these high temperatures were not appropriate for some materials such as non-ceramic esthetic brackets.\(^4\) In
1990s, Hamula who worked on light cured adhesives, reported the advantages of this kind of adhesives.\textsuperscript{5} In 2002, FiltekFlow® (3M ESPE, St.Paul, MN), a flowable composite developed for use in tunnel preparations, class IV cavities and fissure sealant, was incorporated into indirect bonding by Miles. Thus, this material reduced void risks under bracket base, and good handling of composite was achieved.\textsuperscript{6}

\textbf{THE ADVANTAGES OF INDIRECT BONDING:}
There are some significant advantages to indirect bonding\textsuperscript{7-12}:

1. Accurate bracket positioning
2. Reduced chair side time
3. Avoiding band on posterior teeth
4. No need for separators
5. Enhance ability to bond posterior teeth
6. Enhance patient comfort and hygiene

\textbf{DISADVANTAGES OF INDIRECT BONDING}
1. Technique sensitive
2. Extra set of impressions needed
3. Posterior attachments more likely to debond if patient chews.

\textbf{INDIRECT BONDING STEPS}
Most current techniques use composite resin custom bracket bases (light cured, thermally cured, or chemically cured) and a chemically cured sealant as the clinical bonding resin. The following procedure may be useful:

1. Take an impression and pour up a stone (not plaster) model.
2. Select brackets for each tooth.
3. Isolate the stone model with a separating medium.
4. Attach the brackets to the teeth on the model with light-cured or thermally cured composite resin, or use adhesive precoated brackets.
5. Check all measurements and alignments, reposition if needed.
6. Make a transfer tray for the brackets. Material can be putty silicone, thermoplastics, or similar.
7. After removing the transfer trays, gently sandblast the adhesive bases with a micro etching unit, taking care not to abrade the resin base. 

8. Apply acetone to the bases to dissolve the remaining separating medium.

9. Prepare the patient’s teeth as for a direct application.

10. Apply Sondhi Rapid Set resin A to the tooth surfaces and resin B to the bracket bases. (If Custom I.Q. is used, apply resin B to the teeth and resin A to the bases).

11. Seat the tray on the prepared arch and with the fingers apply equal pressure to the occlusal, labial, and buccal surfaces. Hold for a minimum of 30 seconds, and allow for 2 minutes or more of curing time before removing the tray.

12. Remove excess flash of resin from the gingival and contact areas of the teeth with a scaler or contra angle hand piece and tungsten carbide bur. 

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Indirect bonding using light-cured base composite (Transbond XT) and chemically cured sealant (Sondhi Rapid Set)
DIFFERENT INDIRECT BONDING TECHNIQUES

The sondhi method

In this technique, the viscosity of the new resins was increased, so, it had an ability of filling any voids. They used resin A for the tooth surface and resin B for the bracket base. For the transfer trays, they used two different layers; one inside (BioplastÔ) is softer as compared to the outer one (Biocryl™).13

The vashi method

In this technique, they used a combination of thermoplastic glue and impression compound to prepare a transfer tray, impression compound is warmed and applied onto the occlusal and lingual surfaces of the teeth of the working models. After that, the brackets are placed onto the working models. Then, the glue is flowed from glue gun, adheres to the impression compound, and covers the brackets on all sides.14

Indirect bonding with a thermal cured composite

Thermal cured composite material has the advantage of creating sufficient working time. The working models with the brackets are placed in an oven for curing at 325°F for 15 minutes. For the transfer trays, the polyvinyl siloxane impression material is applied over the thermally cured brackets. Then, vacuum-form thermoplastic material is used over the working model, brackets, and impression material complex.15

A technique for precision and efficiency by Guenthner and Larson

In this technique, the researchers offer two types of composites for bonding brackets onto the working models; thermally cured adhesive or APC (adhesive pre-coated) system. Also, there is a different transfer tray fabrication in this technique. They use two parts of a vinyl polysiloxane putty material that is mixed with fingers. When the material is mixed, it is quite fluid and can easily flow and capture the undercuts of the brackets. This holds the brackets securely in the trays. The tray should be about 5 mm thick. This thickness provides enough support and rigidity. The trays are separated into segments for the 4 quadrants of the jaws and trimmed away from each other in the midline.16
Prescription-based precision full arch indirect bonding

In this technique, the researchers draw vertical long axis lines on the models; these lines indicate the long axes of the teeth. Next, they draw horizontal lines on both models on the molars and bicusps connecting the mesial and distal marginal ridges. They measure 2 mm between the tips of the divider, and then transfer this measurement to the models by making a mark on the vertical lines (decrease 0.5 mm for second molar). By using this mark they draw second line parallel to the marginal ridge line. The 2 mm slot line is arbitrary, so a clinician can choose 2.5 mm for larger teeth if suitable. Till now, they finished all lines of the posterior teeth. By measuring the distance from the cusp tip on the first bicuspid to the slot line (it is usually 4.5 mm), they find the upper central incisors slot lines. They decrease the measurement by 0.5 mm for the lateral incisors increase the measurement by 0.5 mm (same as central incisors) for the upper canines again. For the posterior part of the lower arch, the same methods are used including long axis lines, marginal ridge lines, and slot lines. The measurement for the distance from the cusp tip on the first bicuspid to the slot line is obtained and is transferred to the mandibular central and laterals. For the lower canines, this measurement is increased by 0.5 mm. At the end, by placing these lines on the working models, a truly customized prescription is created. For the composites, a two-part dual cure resin can be mixed and placed on the bracket base. A light-cured adhesive can also be used. For the fabrication of transfer trays, they use polyvinyl siloxane material. For the bonding on the teeth, they use Sondhi Rapid Set® (3M Unitek) or Custom IQ® (Reliance Orthodontics, Itasca, IL).17,18

Indirect bonding in lingual orthodontics

Indirect bonding is preferred in lingual orthodontics because;

• Lingual tooth structure variations complicates the fabrication of a standard bracket
• Difficult to obtain an ideal view for bonding.
• If there is a mistake on bracket positions, it is also difficult to bend the arch wire for correction.
• Lesser familiarity to the lingual tooth morphologies.17

There are several indirect bonding techniques for lingual orthodontics. Orapix® (Orapix, Seoul, Korea) system showed improved results.19 Another system, Incognito® (TOP Service, Bad Essen, Germany) System reduces bond failure rate and provides better results.20
Transfer accuracy of vinyl polysiloxane trays for indirect bonding

In this technique researchers found that indirect bonding using VPS trays transfers the planned bracket position from the dental cast to the patient’s dentition with greater positional accuracy.\textsuperscript{21}

CONCLUSION

For orthodontic practitioners, adopting the latest technology can help you deliver an enhanced level of treatment and impressive results for your patient that can contribute to a thriving practice. There are many high technology computer-driven systems were developed for indirect bonding. Among these systems, SureSmile\textsuperscript{®} system (Orametrix Inc., Richardson, TX), captures in vivo images of the dentition is based on intra-oral scanner. Therefore, bracket positions are established, and custom indirect bonding transfer trays are constructed.\textsuperscript{22,23} In another system, OrthoCAD\textsuperscript{®} (Cadent Inc., Carlstadt, NJ), digital models are created using plaster models. Rest is same as in SureSmile\textsuperscript{®} system.\textsuperscript{24,25}

In a discussion on indirect bonding, the researchers were questioned about indirect bonding. Thomas stated that indirect bonding takes less clinical time (chair time) and bracket positioning is more accurate with the success rate of 98%. And Zachrisson confirmed that it is better to position brackets on models.\textsuperscript{26}

The improvement in tools and techniques enable us to achieve great results with far less discomfort and in a much shorter treatment time than was ever before possible.

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