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Gauging denture retention: A comparative analysis of conventional vs. light-cure border molding materials on retention of maxillary denture base using force gauge: A clinical study

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Abstract
Purpose: This *in vivo* study aimed to evaluate and compare the retention of maxillary denture bases fabricated using border molding with conventional low-fusing impression compound and light-cure resin material, objectively measured using a digital force gauge.
Materials and Methods: Completely edentulous patients requiring complete denture prostheses in the department of prosthodontics, crown and bridge govt. dental college and hospital were included in the study. In this study we performed Border molding techniques using conventional technique for (Group 1) and with light-cure acrylic for (Group 2). Both techniques were used in same patient and by same operator to minimize variability. Further, Secondary impressions was made using light-body addition silicone for light cure acrylic trays and for conventional method zinc oxide eugenol paste was used. The obtained impressions were poured with type III dental stone and casts were retrieved. Retention of the denture bases fabricated on the casts were measured using a digital force gauge intraorally, and results were statistically analyzed using the paired t-test with additional analysis for effect size and confidence intervals.
Results: The retention values for maxillary denture bases fabricated using light-cure resin were higher than those using conventional low-fusing impression compound. Statistically, there was a difference between the two groups ($t = -3.12$, $p = 0.0054$), with light-cure resin showing a mean increase in retention of 1.30 N (0.13 kgf) compared to the standard compound. The 95% confidence interval (CI) ranged from -2.15 N to -0.45 N, indicating a measurable advantage of light-cure resin. However, the effect size (Cohen's $d = 0.47$) suggests that the difference, while statistically significant, may have limited clinical relevance.
Conclusion: This study demonstrated that both conventional and light-cure border molding techniques provided clinically acceptable retention for maxillary denture bases. The light-cure resin exhibited statistically significant higher retention values. However, the handling advantages of light-cure resin, including ease of adaptation, time efficiency, and elimination of multiple heating cycles, make it an attractive alternative for clinicians seeking streamlined procedures. Future research should focus on assessing long-term clinical performance, patient comfort, and cost-effectiveness to establish its broader clinical applicability.

Keywords: Elastic modulus, flexural strength, provisional restorative materials

Introduction
In the realm of complete denture prosthodontics, achieving optimal retention and stability of the denture base is paramount during tissue movement recording. This necessitates the careful selection of appropriate dental materials and techniques for establishing precise denture borders. The final impression stage plays a pivotal role in this process, involving border molding the custom tray to snugly fit in the vestibule. While the traditional low fusing impression compound has been used historically, it has drawbacks such as requiring multiple steps and lacking simultaneous molding of all borders, potentially leading to errors and time constraints [1]. Despite the fact that the sectional technique is taught at dentistry schools

at regular basis and is utilized by a significant number of general dental practitioners, it is not without its drawbacks. The introduction of elastomeric impression materials [Skinner and Cooper, J Am Dent Assoc 51:523-536, 1955] has made possible new techniques of recording impression for complete denture construction [2]. Apart from low fusing impression materials other materials that had be utilized are putty elastomeric impression materials, polyether, mouth temperature waxes and soft liners [3]. The optimal qualities for border molding that a material should posses- It should be nontoxic and nonirritating, and it should be able to flow to all places. It should be possible for the material to reproduce the tissues with a minimal number of efforts [4]. Boucher laid out 5 primary objectives of complete denture (CD) impressions: retention; stability; support; esthetic value; and the preservation of the alveolar ridge [5].

Recently, light-cure resin has emerged as a promising alternative, offering enhanced adaptability, desired setting time, requires less armamentarium [6].But single-step border molding is more Technique sensitive, as the entire vestibular sulcus and posterior palatal seal area need to be recorded accurately in a single insertion. Hence, the material used for this technique should provide optimum working time, have adequate body, and permit the correction of border molding by additions. The majority of practitioners have maintained to employ the methods of denture construction that they acquired in dentistry school; however, they frequently adjust their impression processes in order to reflect the usage of more modern materials that are more effective. According to Burton (2000), the majority of physicians emphasize the significance of enhancing the efficiency of the denture manufacture process [7].Another anonymous questionnaire, in 2003, confirmed that the majority of the reporting prosthodontists (88%) and dental schools (98%) use a border-molded custom tray for final impressions for complete denture prosthodontics. The most popular material for border molding was a plastic modeling compound. Variability of the materials used for final impressions was observed, with the most popular materials being polyvinylsiloxane for the ACP members (36%) and polysulfide for the dental schools (64%).The choice of impression materials used today in dental schools shows how schools are moving toward newer materials and techniques and away from traditional materials [8].

Thus, this study aims to evaluate and compare two different methods for border molding - a conventional approach with TYPE-1 low fusing impression compound and another with light-cure acrylic resin. By analyzing these techniques, our goal is to find out whether light-cure resin can be a practical alternative to conventional method and provide an evidence-based insights into clinical efficiency and patient outcomes in complete denture fabrication. Further, Retention will be objectively measured using a digital force gauge, ensuring precise, quantifiable data.

Materials and Methods

Study sample

This study included individuals seeking prosthodontic care and voluntarily agreed to participate. We screened each participant carefully to ensure they met the inclusion criteria of this research. A clinical study was conducted in the department of prosthodontics, Crown and Bridge Govt. Dental College and hospital, Srinagar, a comparative analysis of conventional vs light cure border molding materials on retention of maxillary denture base was done and objectively measured using digital force guage. A total of 31 participants were involved. In this study all participants provided an informed consent prior to participation. To ensure standardization during the study, all procedures were performed by same operator.

Location: Outpatient Department of Prosthodontics, Government Dental College and hospital, Srinagar

1. Study design

This study was designed as a prospective comparative clinical study.

- **Comparative Experimental Study:** Comparing two techniques (Green Stick vs. Light-Cure material) for border molding and analyzing their effect on maxillary denture retention using a force gauge.
- **Quantitative Analysis:** The study involves numerical data collection (retention forces in Newtons and kgf), followed by statistical analysis. Within-Subject Design (Paired Comparison) - Since retention forces were measured in the same patients using both Green Stick and Light-Cure materials, it is a paired comparison study.

2. Ethical approval

The Research Ethics Committee of Government Dental College and Hospital, Srinagar approved the protocol of this study.

3. Pre-procedural assessment, clinical examination

3.1 History a detailed medical, dental history was taken from each patient; which usually included any systemic disease, habits that may have affect on study.

Armamentarium-

- Impression Trays. Stock impression trays. Custom impression trays
- Impression Materials. Impression compound, Green stick impression compound, Light cure denture base resin resin (VocoProfibase), Elastomeric impression material, Digital force gauge (for measuring retention),Light cure unit

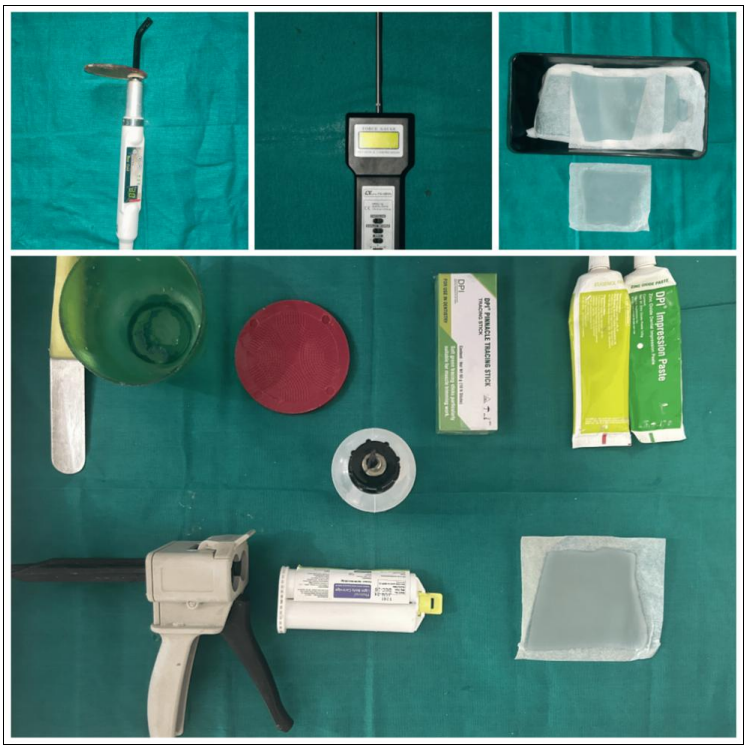

Fig 1: Armamentarium

Fig 2: a) Light cure custom Tray material b) Force gauge - device displays the dislodging forces in newtons and registers the peak force

Selection Criteria

Inclusion Criteria: Completely edentulous patients with well-preserved ridges, no significant undercuts or bony exostoses normal temporomandibular joint function. Exclusion Criteria: Excessive ridge resorption, flabby ridges or hyperplastic tissue, patients with neuromuscular disorders affecting oral function

Methodology

This study was conducted on 31 randomly selected completely edentulous patients that visited the department. The patient's denture bases were categorized into two groups based on the border molding technique used:

Group A: Border molding using green stick impression compound

Group B: Border molding using Light cure resin

Firstly, Primary upper arch impressions were made using a suitably selected impression stock tray. These impressions were then poured with dental plaster to create a primary impression cast. The impression cast were properly outlined, and relief was given for the fabrication of individualized and customized impression trays using auto-polymerizing acrylic resin material and light cure resin.

Group 1: Conventional Border Molding

This technique utilized type 1 low-fusing impression compound. The material was heated using an open flame until it became moldable. It was then applied incrementally along the periphery of the custom tray and carefully adapted to the vestibular tissues. After achieving an initial adaptation, the material was tempered in a water bath to ensure proper working temperature. The tray was then inserted into the patient's mouth, and functional movements were performed to shape the material according to the dynamic tissue contours. This step was repeated sequentially in sections until the entire border was molded.

Fig 3: Group A: Coventional Border molding and wash impression using zinc oxide eugenol paste

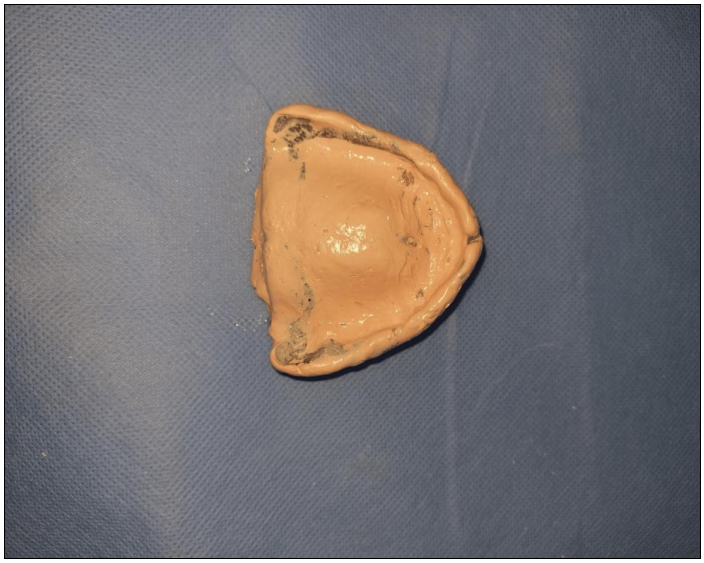

Figure 4: conventional technique- Border molding using type I compound and final wash impression was made using zinc oxide eugenol.

Group 2: Light-Cure Resin Border Molding

This technique used light-cure resin in a single-step application. The material was directly applied to the periphery of the custom tray in a uniform layer. The tray was then seated in the patient's mouth, and functional movements were performed to adapt the material to the oral tissues. Once the adaptation was achieved, the resin was polymerized in situ using a dental curing light, ensuring precise shaping without the need for reheating or incremental applications. This process streamlined the procedure, reducing chairside time and enhancing efficiency.

Fig 5: Technique using light-cure resin in a single-step application for border molding followed by polymerization in situ using a dental curing light.

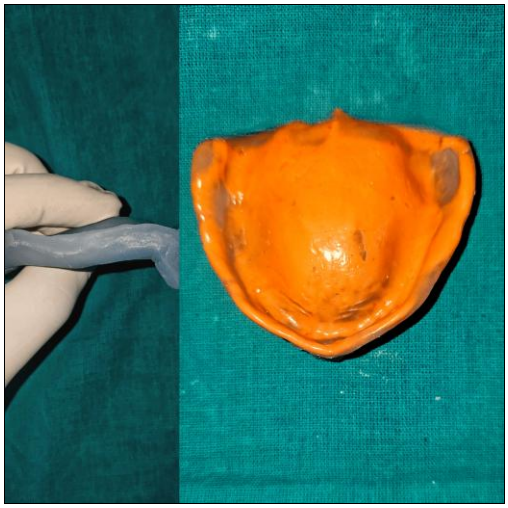

Fig 6: Border molding and final wash impressions made using light-body addition silicone to accurately capture fine details.

Following the completion of the final impression procedure, impressions were disinfected and master casts were prepared by pouring the obtained impressions using type IV dental stone.

Fig 7: Master casts prepared by type IV die stone A- conventional B- Light cure technique

Permanent denture bases were fabricated using heat-cure acrylic material. A loop will be prepared by using a '19-gauge' stainless steel wire which will be attached to anterior palatal area of denture bases which will approximately corresponding with the line joining distal canine surfac

Fig 8: Permanent denture bases were then fabricated using heat-cure acrylic resin. A loop was prepared using a '19-gauge' stainless steel wire which was attached to anterior palatal area of denture bases

Further a digital force measurement gauge was used to record vertical dislodging forces. Device displays the dislodging forces in Newton and kg-f and and registers the peak force. For each denture base three consecutive readings were taken and the mean value was noted.

Fig 9: A digital force measurement gauge was used to record the retention of each maxillary denture base in the patient while maintaining the Frankfort horizontal (FH) plane parallel to the floor. Measurements were taken for two groups: (A) Green Stick Compound and (B) Light-Cure Material

Results

Table 1: A Comparative Analysis of Conventional vs Light-Cure Border Molding Materials on Retention of Maxillary Denture Base Using Force Gauge

Case	Green Stick (N)	Green Stick (kgf)	Light-Cure (N)	Light-Cure (kgf)
1	50.6	5.16	47.8	4.87
2	30.3	3.09	27.8	3.00
3	50.1	5.109	54.6	5.50
4	28.1	2.7	29.4	2.94
5	44.3	4.5	47.1	4.80

6	42.1	4.2	53.6	5.46
7	50.5	5.1	55.9	5.69
8	27.5	2.80	28.4	2.89
9	28.3	2.88	29.8	3.03
10	40.6	4.1	44.8	4.44
11	32.5	3.3	30.8	5.11
12	51.1	5.11	51.1	5.41
13	53.9	5.39	56.2	5.72
14	40.3	4.10	46.1	4.59
15	45.8	4.70	50.3	5.13
16	51.5	5.20	57.8	5.89
17	53.6	5.46	57.9	5.904
18	39.7	4.04	42.4	4.32

Retention values for maxillary denture bases fabricated using light-cure resin were higher than those using conventional low-fusing impression compound. The paired t-test revealed a statistically significant difference ($t = -3.12$, $p = 0.0054$), with light-cure resin demonstrating a mean retention increase of 1.30 N (0.13 kgf) compared to conventional compound. The 95% confidence interval (CI) ranged from -2.15 N to -0.45 N, indicating a measurable advantage of light-cure resin. However, the effect size (Cohen's $d = 0.47$) suggests that the difference, while statistically significant, may have limited clinical relevance.

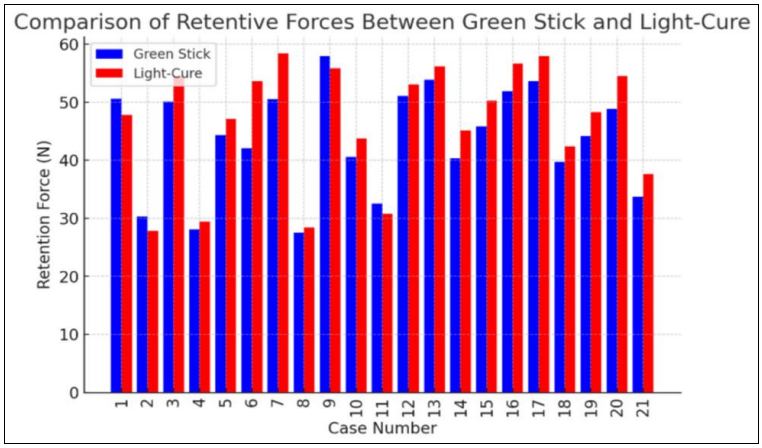

Fig 10: Bar chart comparing the retentive forces between Green Stick and Light-Cure materials across all cases.

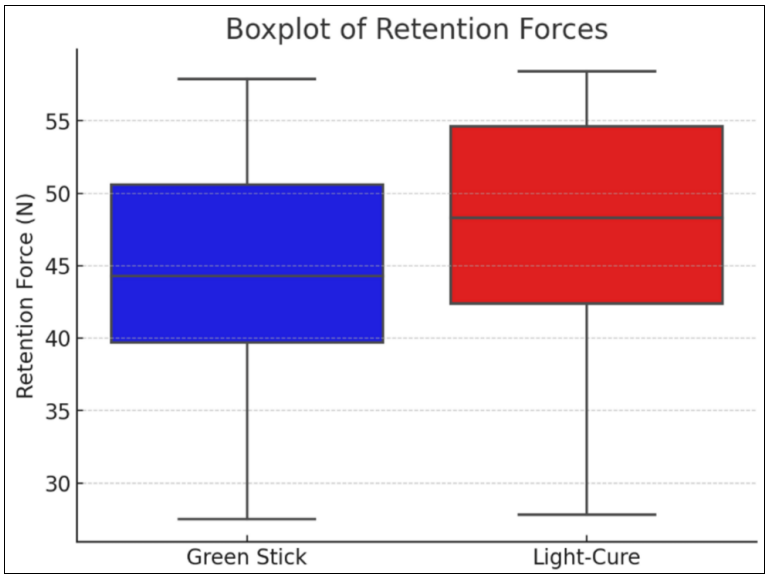

Fig 11: Showcasing the spread, median, and outliers for retention forces of Green Stick and Light-Cure materials

Green Stick: Mean Retention: 43.70 N, Standard Deviation: 9.06 N, Median: 44.3 N, Range: 27.5 - 57.9 N
Light-Cure: Mean Retention: 46.65 N, Standard Deviation: 10.30 N, Median: 48.3 N, Range: 27.8 - 58.4 N
Paired t-test Results: t-statistic: -3.93, p-value: 0.0008 (Highly significant, $p < 0.05$)

Interpretation

Light-cure material showed slightly higher mean retention than the green stick.

The statistical significance (p-value < 0.05) suggests that light-cure material provides a improved retention over green stick compound.

Discussion

The findings of this study demonstrated that light-cure resin border molding offers handling advantages over conventional low-fusing impression compound, particularly in its efficiency and adaptability to oral tissues. The elimination of multiple heating cycles and direct intraoral polymerization allowed for better control and reduced chairside time. Additionally, patient discomfort was minimized, enhancing compliance during the impression process. The statistical increase in retention observed with light-cure resin suggests its potential as a viable alternative. However, the effect size analysis indicates that the clinical significance of this difference may be limited. Srinivasan Jayaraman[1], Cochrane Library 2018 Apr 4;2018(4) conclude that there is no clear evidence that one technique or material has a substantial advantage over another for making complete dentures [9,10,11]. Impressions made with both materials were clinically acceptable. Clinicians should consider case-specific factors such as ridge morphology, occlusal dynamics, and patient adaptation when selecting a border molding material.

One of the key strengths of this study was the inclusion of secondary impressions taken with light-cure fabricated trays, allowing for a more refined adaptation assessment. Further research is necessary to explore long-term effects on retention, patient comfort, and overall prosthesis stability. Evaluating cost-effectiveness and the impact of operator variability in multi-clinician studies would provide valuable insights for clinical implementation.

Limitations of Light-Cure Acrylic Resin from a Clinician's Perspective

- **Incomplete Polymerization:** May not fully polymerize in areas with limited light penetration, leading to compromised mechanical properties in thicker sections or shaded areas.
- **Technique Sensitivity:** Optimal results depend on precise light exposure and technique.
- **Brittleness:** More brittle compared to conventional acrylics, making it more prone to fractures under stress.
- **Dust Generation During Trimming:** While it is easier to trim, it tends to produce a significant amount of fine dust.

Conclusion

Both techniques provided favorable retention; however, light-cure resin showed advantages in certain cases, due to its material properties and ease of handling. Although the retention differences between the two materials and techniques were not significantly different and could potentially be attributed to clinician-related factors in technique execution. Both conventional and light-cure border molding techniques provided satisfactory retention for maxillary denture bases. The light-cure technique exhibited handling advantages and slightly higher retention values, though the differences were not clinically ground breaking. The study suggests that light-cure resin can be considered a viable, efficient alternative for border molding, particularly in settings where time efficiency is crucial. Further research is necessary to validate these findings and explore additional clinical applications.

Conflict of interest: Nil

Funding: Nil

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