

COMPOSITE LAYERING TECHNIQUES IN DIRECT ANTERIOR RESTORATIONS: A SCOPING REVIEW ON LONGEVITY AND CLINICAL OUTCOMES

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ABSTRACT

Background and aims: The appearance and function of the upper anterior teeth significantly impacts self-esteem. Managing carious and non-carious lesions is essential, and this review evaluates composite layering techniques used in restorations. It aims to elucidate selection criteria based on clinical conditions and desired outcomes. **Methods:** A literature search was conducted, resulting in an initial pool of 336 articles. Thirty-two relevant articles were then selected for analysis. The inclusion criteria included assessment of the causes of tooth loss, the condition of the teeth left, their original colour and the need for better oral hygiene. **Results:** The results showed that direct composite restorations are a feasible and cost-effective alternative to indirect veneers, providing satisfactory results. Success of restorations depends on accurate planning and effective occlusal management. Analysis revealed high survival rates of direct composite methods, showing their appropriateness under different conditions. **Conclusions:** Direct composite restoration techniques offer significant advantages in restoring aesthetics and function of the maxillary anterior region. Technique should be chosen based on detailed clinical assessment and patient-specific factors to optimise results. The review backs wider use of these methods, highlighting how good they are.

Keywords: dental materials, composite resins, treatment outcome, clinical decision-making, dental bonding, dental techniques

INTRODUCTION

The restoration of superior anterior teeth is challenging because of function and aesthetics, so an integrated approach is key to achieving an optimal outcome [1]. The direct restoration method involves layering composite resins onto the tooth in the clinic. This technique can be performed in two ways: directly or using a custom-made matrix. It allows for modifications to dental dimensions to enhance appearance and restore teeth affected by fractures, carious lesions, or tooth wear [2].

Direct restoration allows for changes to tooth shape, improving appearance through procedures such as closing gaps, small shape-changes or repairing teeth with damage, carious lesions or wear and tear. Advances in restorative materials also enable shade modifications, for one tooth or an entire sextant, if needed. However, challenges often arise due to clinical situations, requiring bespoke adaptations to the restoration process for each patient.

Investigations of clinician techniques are often essential to understand why they use

them, as well as to improve patients' lives and self-esteem. The success of dental restoration relies on precise treatment and consideration of the patient's aesthetic preferences [3].

During treatment planning, consider etiology of hard-tissue loss, quantity/quality of remaining teeth, discolouration, tooth colour, occlusal alterations, and hygiene needs. These inform choice of direct/indirect methods. In direct restorative methods, the selection of materials and restoration techniques is important [2-4].

This scoping review evaluates and synthesizes composite layering techniques for direct upper anterior teeth restoration. It explores their use in diverse clinical scenarios to provide insights into decision-making and effectiveness. The aim is a comprehensive overview of technique application and innovation. Dental practitioners adapt restoration strategies based on factors like the cause of dental issues, tooth colour and overall dental health. The review assesses the long-term efficacy and patient satisfaction of these techniques.

MATERIALS AND METHODS

This study represents a scoping review designed to assess, compare, and synthesize the available literature on composite layering techniques for direct restoration of anterior teeth. The methodology followed the guidelines outlined in the PRISMA Extension for Scoping Reviews (PRISMA-ScR). The review's objectives, research questions, and scope were developed through consultations with clinical experts in dentistry to ensure clinical relevance and alignment with current research priorities. The review protocol was registered on the **Protocols.io** platform, ensuring transparency and reproducibility of the research process (Protocol registration link:

[https://www.protocols.io/edit/comparative-](https://www.protocols.io/edit/comparative-analysis-of-composite-layering-techniques-drip54mn)

[analysis-of-composite-layering-techniques-drip54mn](https://www.protocols.io/edit/comparative-analysis-of-composite-layering-techniques-drip54mn))

2.1 Eligibility criteria

The inclusion criteria were as follows: (1) studies published between 2014 and 2024; (2) studies available in full text; (3) studies written in English; (4) studies focusing on the planning, treatment, and outcomes of cases treated using direct composite restoration; (5) randomized clinical trials, cohort studies, case-control studies, case reports, and short communications.

The following exclusion criteria were considered: (1) abstract-only papers; (2) studies with topics not aligned with the subject of our paper; (3) articles that could not be accessed in full text (4) studies whose subjects could not be integrated into the study's focus; (5) articles written in languages other than English.

Information sources:

A structured search was conducted from March to April 2024 in PubMed and EMBASE, using both MeSH and Emtree terms. Additional handsearching of relevant studies was performed. Keywords included "direct composite," "anterior teeth," and "esthetic." Articles were organized using Mendeley Reference Manager v2.101.0.

Data Extraction and Quality Assessment:

Data extracted included study design, participant demographics, intervention details, and outcomes. The quality of included studies was assessed using established assessment tools to gauge study reliability and validity.

Data analysis:

Data were synthesized qualitatively to map out the breadth of literature, identifying common findings and noting methodological variations among the studies.

Ethical Considerations:

As this scoping review only involved published data, no ethical approval was required. However, all processes were designed to adhere to ethical research standards.

RESULTS

ScienceDirect Database Search

A detailed search was initiated in the ScienceDirect database, yielding 287 articles. Focusing on publications from 2014 to 2024 narrowed this field to 164 articles. The inclusion of only research articles, case reports and short communications further reduced the total number to 89 articles. After applying language criteria and assessing titles and abstracts for relevance, 25 articles were initially deemed eligible. However, five of these were not available in full, leading to a

final count of 20 articles that were fully reviewed. On closer examination, 13 articles met all review criteria and were selected for inclusion in this study.

Overall Article Inclusion

A total of 32 articles were found to meet the requirements for this literature review: 13 from ScienceDirect, 16 from PubMed, and 3 from manual search. This comprehensive selection process ensured that only articles most relevant to the direct composite restoration of anterior teeth and esthetic outcomes were included, providing a robust foundation for analyzing the effectiveness of various restoration techniques. The articles were thoroughly reviewed, and relevant data were extracted and analyzed.

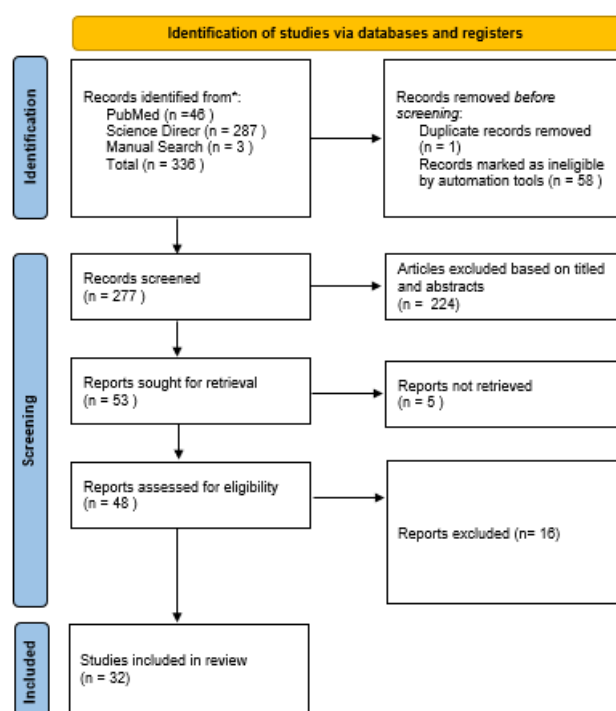


Figure 1. - PRISMA diagram.

Description of the studies and analysis:

The primary features of the studies selected for inclusion in this review were depicted through graphs and subjected to

detailed analysis. Our research concentrated on specialized articles that addressed the restoration of the upper anterior teeth group using direct composite layering techniques. These studies offered in-depth descriptions of

various techniques, underscored specific challenges encountered during the restoration process, and examined the longevity and

A total of 32 articles were included in this paper. Most of them, 22 in number, representing 69%, were case studies describing the technique used, while 10 studies were retrospective studies describing the status of fillings after various time intervals.

The articles included in the study were thoroughly reviewed to determine the percentage at which each of the mentioned etiologies contributes to the need for direct veneers to improve patient's aesthetic function. As a result, the predominant etiology was dental fracture, accounting for 34% of the studies addressing cases of anterior dental fractures. This was followed by dental wear, representing 24%, diastemas (15% of the studies), and color anomalies (reported in 15% of the studies). Other etiologies leading patients to seek treatment included shape anomalies (6%), carious etiology (3%), and unspecified causes (3% of the studies).

An analysis of composite layering techniques reported in studies revealed that out of a total of 32 studies, 13 reported using the silicone key layering technique. Four studies addressed the 'freehand' technique, while four of them reported using the "direct shaping by occlusion" technique. The incremental technique and "polychromatic layering" were each reported by two studies. Additionally, the "Canine rise", "Pre-finishing" and layering on a temporary transparent crown were each reported by one study. Two studies did not specify the layering technique used.

Out of the 32 studies, 21 did not report the need for precursor treatments, but this need was reported by 11 of them, representing 34%. Among these 11 studies, 7

survival rates of these restorations across various time periods.

reported the need for an increase in vertical dimension of occlusion (VDO), 3 of them mentioned the need for orthodontic treatment prior to direct veneering, and one study reported the need for other treatments .

Among the studies that reported the need for precursor treatments for direct veneering, a considerable percentage, 64%, reported the need for an increase in VDO, 27% reported the need for orthodontic treatment, and 9% reported the need for other treatments.

The high percentage of dental wear reported by the studies included in the review prompted an analysis of these cases. It was determined that among the studies that reported dental wear as the etiology leading to the need for direct veneering of the upper anterior group, 87% reported the presence of VDO modifications. There was a 13% proportion of these studies that did not specify these modifications.

In the case of dental wear, articles were analyzed to determine the layering techniques used for restoring cases where wear was reported. Furthermore, the techniques employed to enable necessary VDO modifications were identified. Among the 8 studies that focused on restoring cases with dental wear etiology, 4 reported using the "direct shaping by occlusion" technique, 2 reported using the stratification technique with a silicon guide, 1 study mentioned using the "canine rise" technique, and one study did not specify the technique used. Furthermore, 3 of the studies reported using silicon occlusal stops to materialize the new occlusion, while one study reported using an occlusal deprogrammer.

In the articles included in the review, color anomalies were specified as the cause

for the need of restoration through direct layering of composite materials in 15% of the articles. Consequently, these articles were selected and analyzed, determining that 40% of the articles related to tooth restoration with color anomalies had fluorosis as the primary identified etiology. Additionally, 20% of the articles described amelogenesis imperfecta as a primary cause and 40% described loss of tooth vitality as the primary cause.

Dental fractures were the dominant reported etiology in the articles included in the review. Consequently, the types of restoration techniques for these cases were studied. Six of the articles described the use of the silicone key layering technique in the presented cases, one study reported using the “index cutback” technique, four studies mentioned other techniques, and one study did not specify the restoration technique used. These aspects will be discussed in detail in the “Discussion” chapter.

The silicone key layering technique was the preferred method in 13 out of the 32 articles included in the review, representing 40%. The etiologies for which authors favored the use of this technique for the cases described in their articles were analyzed. Consequently, this technique was employed in seven articles describing cases with dental fracture etiology, as well as in two articles discussing restoration of diastemas, three articles each describing dental color anomalies and dental wear. One article described using the technique for shape modification in dental form anomalies, while another applied it to carious etiology.

The Freehand technique was reported to be used in 4 out of the articles included in the review. Specifically, three of the articles, representing 75% of those describing the use of this technique, discussed its application in closing diastemas. Additionally, one article,

accounting for 25%, described using the technique for color anomalies.

From a total of 32 studies, 10 were retrospective studies aimed at verifying the survival rate of various cases of direct veneers, representing 31% of the total studies. Among these studies, 3 evaluated the condition of direct veneers after 2 years or less, constituting 30%, 4 described their condition within an interval of 2 to 5 years from the veneering date, representing 40%, and 5 studies assessed the condition of veneers in the 5 to 10-year interval, accounting for 50%.

DISCUSSION

The articles featured in this scoping review focus on detailing various restoration techniques for the upper anterior teeth, alongside the necessary case planning and therapeutic strategies implemented before initiating treatment. Additionally, they explore the longevity and efficacy of these restorations over designated time periods as specified by each study. The case report studies present patients with lesions to the upper anterior dental group, which received customized treatments using direct veneering techniques, and carefully adapted to meet the specific underlying etiologies and individual requirements of each patient.

4.1. Restoration Techniques

Stratification technique with silicone guide

Romero et al.'s research exemplifies the stratification technique using a silicone guide, a method applied to a patient with a vital tooth featuring intact enamel [9]. This process begins with a careful aesthetic evaluation of neighboring teeth and gingival architecture, followed by strategic beveling of the tooth's lingual and vestibular surfaces. The selected and described technique for direct veneering was the stratification

technique using a silicone guide. This involved applying composite material corresponding to the enamel on the palatal side of the sectioned silicone guide, followed by forming the proximal surfaces with the same material to create a frame. Composite stratification was then performed on this frame to reconstruct dentin, which would later be covered by the vestibular enamel layer. The composite materials were finished according to protocol.

Incremental and composite layering techniques

Further exploring the nuances of direct veneering, other studies such as those by Romero M. [10, 14] and Amaro et al. [32] focus on specific adaptations based on the fracture's characteristics and aesthetic requirements. For instance, Amaro et al. highlight the importance of symmetry and the use of the "button try" technique for color matching, which is complemented by silicone guide layering and the "Unica" matrix for optimal results [32].

4.2. Case Planning and Therapeutic Approach

Pre-Treatment assessments and adjustments

The preliminary steps before initiating direct veneering are critical for successful outcomes. These include recording tooth color, assessing gingival architecture, and deciding on the direct treatment approach. Romero M.'s case report [14] involves precise adjustments such as beveling at specific angles and using abrasive discs for proximal margins, demonstrating the detailed preparation necessary for high-quality restorations.

Technique-specific preparations

Each case requires unique preparatory steps tailored to the etiology and patient-specific factors. For example, Paolone et al. [33-34] discuss managing

symmetry and aesthetics by modifying fracture lines and using calibrated burs to bevel margins, ensuring uniformity in thickness and translucency across restored teeth.

4.3. Survival Rates and Longevity of Restorations

Long-term outcomes and technique effectiveness

The durability of direct veneering techniques is a focal point of several studies. Avinash et al. [31] introduce the "index cut-back" layering technique, designed to refine the wax-up for enamel application, enhancing both the esthetics and longevity of Class IV cavity restorations. Similarly, Kermanshah et al. [27] detail the "canine rise" technique, which addresses generalized dental wear by prioritizing the restoration of maxillary canines to create necessary spatial accommodations for comprehensive dental work.

Innovations in restoration techniques

The advancements in techniques also include the "Pre-finishing" method described by Paolone et al. [34], which involves finishing enamel margins before applying dentin-simulating materials. By implementing this method, the authors aim to improve the bonding and aesthetic alignment between different composite layers, potentially extending the restoration's lifespan.

4.4. Patient-Centered Outcomes

Impact on quality of life

Restoring the aesthetic and functional integrity of upper anterior teeth significantly impacts patient self-esteem and psychological well-being. Techniques that enhance aesthetic outcomes and minimize invasive procedures, such as those employing silicone guides, are associated with higher patient satisfaction due to their minimal

invasiveness and superior aesthetic results [9].

Aesthetic satisfaction

Direct veneering techniques provide the advantage of detailed color matching and structural integration with existing teeth, which are crucial for achieving aesthetic outcomes that meet patient expectations. The "button try" technique for color matching ensures that restorations blend seamlessly, enhancing patient acceptance and satisfaction [32].

Functional outcomes

Functional improvements such as enhanced chewing efficiency and comfort are pivotal. Techniques that consider functional mastication alongside aesthetics, such as the "canine rise" technique, have been shown to improve overall masticatory function, thereby enhancing patient satisfaction and daily comfort [27].

Long-term satisfaction and maintenance

The durability of restorations influences long-term patient satisfaction. The "Pre-finishing" method, which potentially enhances the bonding and longevity of restorative materials, may reduce the frequency of repairs and replacements, thus promoting sustained patient satisfaction [34].

4.5. Patient education and involvement

Patient education about the restoration process and outcomes can significantly affect satisfaction levels. Engaging patients in their treatment choices ensures they are well-informed and their expectations are properly managed, which is vital for achieving satisfactory outcomes [31].

Addressing patient-specific factors

Tailoring treatments to individual patient needs and preferences, from aesthetic desires to specific functional requirements, is

crucial. The detailed pre-treatment assessments and customizations discussed in the reviewed literature ensure optimal patient-specific outcomes [21].

In comparison with classical techniques, such as those proposed by Paolone et al. [38] for endodontically treated teeth, our findings highlight the increased complexity posed by non-vital teeth, where the need for posts and the loss of natural dentin fluorescence present significant aesthetic and structural challenges. Paolone's approach emphasizes the critical role of the ferrule effect, fiber post placement, and the use of specific restorative materials to compensate for color and structural deficiencies. Additionally, Newton Fahl's polychromatic approach [39] underscores the use of multi-layered composites to achieve lifelike translucency, opalescence, and color gradients, particularly in Class IV restorations. This method aligns with our analysis, as several studies in our review also employed layered composite techniques to achieve optimal aesthetics in anterior restorations.

4.6. Limitations of this research

A primary limitation of this literature review is the considerable variability in restoration techniques and the quality of the included studies. The diverse array of clinical approaches and composite materials used complicates direct comparisons, potentially affecting the clarity and strength of the conclusions regarding the superiority of any technique. Additionally, variations in study quality, such as small sample sizes, lack of randomization, or the absence of control groups, further undermine the reliability of the evidence. Standardizing methodologies and enhancing study designs are essential steps for future research aimed at reducing variability and improving outcome reliability in aesthetic dental restorations.

Another significant limitation is the lack of long-term data on the survival rates and effectiveness of the dental restorations reviewed. Most studies only provide short to medium-term results, which do not comprehensively address the durability of these treatments over longer periods. This limitation restricts our ability to assess the long-term success of various composite layering techniques, a critical factor for informed clinical decision-making. Moreover, the generalizability of the findings may be limited due to demographic variations and disparities in access to dental care, which can significantly impact treatment outcomes. Future research should include longer follow-up periods and a broader demographic range to enhance the relevance and applicability of the findings to diverse populations.

4.7. Clinical implications

Throughout the analysis of 32 articles, a comprehensive understanding has developed, emphasizing that every direct veneering case must begin with a detailed diagnostic phase. This phase should accurately identify the underlying causes necessitating veneering, such as fractures, discoloration, or spacing issues. Addressing these unique patient conditions during the planning stage is pivotal in enhancing the longevity of direct restorations, positioning them as a robust alternative to indirect methods.

The diversity of materials and methods currently available complicates the selection process for each unique restoration. Understanding the specific indications, contraindications, and limitations associated with each technique is vital for making informed decisions from the onset. Material selection must also consider the optimal blend of aesthetic and mechanical properties to meet patient-specific requirements.

Retrospective studies included in this review emphasize the success and survival rates of direct restorative treatments in the anterior area over periods ranging from 1 to 10 years, generally reporting high survival rates. These findings support the notion that direct layering is an effective treatment modality for the upper anterior area, provided the specific etiological factors are carefully managed. Most studies underscore the importance of managing symmetry in restorations, especially when addressing dental fractures and aesthetic disparities adjacent to or opposite the midline.

Dental wear, a common theme among the reviewed articles, often necessitates occlusal rehabilitation to increase the vertical dimension and enhance anterior guidance. Furthermore, in scenarios involving diastema closure or shape modifications, the potential need for orthodontic intervention to manage significant spacing underscores the complexity of achieving aesthetic and functional harmony in direct veneering cases.

Long-term outcomes and potential failure modes

Direct composite restorations are known for their aesthetic appeal and minimally invasive nature. However, the long-term success of these restorations is subject to several influencing factors, which include the type of material used, the technique employed, and patient-specific factors such as oral hygiene and parafunctional habits (e.g., bruxism). Over extended periods, the most commonly reported failure modes include:

Marginal discoloration: Due to microleakage or wear at the margins, discoloration can appear over time, particularly in anterior restorations. Factors such as poor marginal adaptation, incorrect layering, and the use of suboptimal composite materials contribute to this issue.

Fracture or chipping: Mechanical stress from occlusal forces or accidental trauma may lead to fractures, especially in large Class IV restorations. Studies in this review, such as those by Romero et al. and Paolone et al., highlight that the technique used to manage incisal edges and margins can significantly affect the risk of fracture.

Wear and loss of surface gloss: over time, composite restorations may experience surface wear, leading to a dull appearance. This outcome is more evident with certain composite materials, such as micro-hybrid composites, which exhibit higher surface roughness than nano-hybrid or nano-filled composites.

Loss of adhesion or debonding: over time, the adhesive interface may degrade due to water sorption or mechanical fatigue, leading to loss of bond integrity. Studies have shown that the bond strength decreases over the years, particularly in anterior teeth with high exposure to moisture and thermal cycling.

Color instability and staining: Prolonged exposure to pigmented substances (e.g., coffee, tea, red wine) can stain composite restorations. Composites with a high filler content and lower water absorption have been found to better resist color changes.

Strategies to minimize risks and improve longevity

To minimize the risk of failure and improve the long-term outcomes of direct composite restorations, the following strategies are proposed:

Operator skill and training: the success of composite layering techniques depends heavily on operator skill. Techniques such as the “Pre-Finishing” method described by Paolone et al. ensure better adaptation of the composite to the tooth structure, reducing marginal defects that

could later cause microleakage or discoloration. Standardized training and certification for clinicians on complex layering techniques could help reduce failure rates.

Selection of high-performance materials: the choice of composite material directly impacts outcomes. Nano-hybrid and nano-filled composites have demonstrated superior wear resistance, surface polish retention, and color stability over time. Studies have shown that modern nano-hybrids exhibit less marginal discoloration compared to traditional micro-hybrid composites.

Use of advanced bonding systems: adhesive degradation is a common cause of long-term failure. The use of modern universal adhesives with improved hydrophilicity and resistance to hydrolytic degradation may reduce the risk of loss of adhesion. Pre-treatment protocols such as selective enamel etching can further improve bond strength.

Patient education and maintenance: patient-specific factors, such as bruxism, dietary habits, and oral hygiene, play a key role in the longevity of composite restorations. Educating patients on proper oral hygiene, the use of night guards for bruxers, and avoiding the consumption of pigmented beverages (e.g., coffee, tea) can significantly reduce the risk of discoloration and wear. Periodic recall visits should also be emphasized to allow early detection of microleakage or marginal failures.

Technique modifications: adopting advanced layering techniques, such as the use of silicone guides or incremental layering, allows for better control of thickness, shade, and anatomical accuracy. This approach is particularly useful in anterior restorations, where precise control of optical properties (e.g., translucency) is essential.

Regular follow-up and maintenance: routine check-ups are crucial for maintaining restoration integrity. During follow-up, clinicians should assess for early signs of

CONCLUSIONS

Firstly, composite materials are a cost-effective alternative to indirect veneers for restoring upper anterior teeth. Secondly, accurately identifying the causes of tooth loss allows for a restoration approach tailored to each patient. Thirdly, successful direct veneering requires comprehensive documentation of the dental arches. Condition includes a thorough analysis of occlusion and any detrimental habits that could compromise restoration success. In cases of dental wear, adjustment of the vertical dimension of occlusion is critical during treatment planning. For managing diastemas, evaluation of available space and potential use of a mock-up to visualise new forms' integration with the existing dental arch is paramount. Orthodontic treatment is often necessary before veneering to ensure optimal alignment and spacing. In cases of tooth discolouration, a layer of dental substance must be removed to place an opaque layer that masks the discolouration. A restorative material is then applied to restore the tooth's optical properties. In cases of dental fractures, beveling the fracture lines is essential to ensure the composite blends seamlessly with the natural tooth substance. 6. The direct layering technique using a silicone guide, which typically requires two treatment sessions, consistently delivers

microleakage, discoloration, and wear. Early intervention can prevent major failures and avoid the need for complete replacement of restorations.

predictable aesthetic results and durable outcomes. The "pre-finishing" technique further refines this approach by processing the enamel margin in advance, enhancing the aesthetic transitions at the incisal edge and proximal faces of the incisors, ensuring a more polished aesthetic for the restoration.

Supplementary Materials: The data that support the findings of this study are available from the corresponding author, Andreea Kui, upon reasonable request.

Author

Contributions:

Conceptualization, M.E.R. and M.N.; methodology, A.K. and M.E.R.; software, R.D. and S.B.; validation, M.N, A.K. and S.B.; data curation, A.K. and M.E.R.; writing—original draft preparation, M.N and M.F.; writing—review and editing, A.K. and M.F.; visualization, S.B. and M.F.; supervision, A.K. and M.E.R.; project administration, S.B. and R.D. All authors have read and agreed to the published version of the manuscript.

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