Proximal Contour of Class II Composite Restoration: A Literature Review

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Abstract

This paper reviews the literature on the factors that may influence the proximal contour when using direct composite restoration to restore Class II cavities.

An ideal contour between two adjacent teeth is necessary to maintain tooth position and dentition stability, provide a food spillway, and facilitate hygienic cleaning.

Defective proximal contour will contribute to food impaction and restrict interdental cleaning, resulting in periodontal issues and recurrent caries.

Using sectional matrix systems with stiffer band and separation rings is an effective method to create optimal proximal contour compared to flat contour when using circumferential matrix systems.

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Introduction

Establishing an interproximal contour is one primary objective of restorative treatment.[1] A good contour between two adjacent teeth is necessary to maintain tooth position and dentition stability, provide a food spillway, and facilitate hygienic cleaning.[2]

Nowadays, posterior resin composite restorations are a common choice for restoring cavities of various sizes. When patient, operator, and material characteristics are considered properly, they exhibit high survivability.[1] Resin composite can be difficult to employ, especially in Class II cavities, because it can be challenging to rebuild an entire proximal surface, in particular, a good contour and contact.[3] A sufficient proximal contour and contact tightness are two factors that are critical in balancing the dental element and, therefore, in periodontal health.[4] A poor restorative approach that results in a defective proximal contour contributes to food impaction and restricts interdental cleaning, resulting in microbial biofilm accumulation in the cervical region and, eventually, recurrent caries.[2] In addition defective proximal contour may also result in a narrower marginal ridge that is less fracture-resistant than a more voluminous marginal ridge.[5]

Proximal contours include both the buccolingual and occlusogingival outlines of the restored tooth on the proximal aspect.[6] When possible, it is recommended to restore the tooth's natural contour.[2] Furthermore, the contour of the proximal surface should be replicated in both directions in respect to the natural buccal, lingual, occlusal, and gingival embrasure.[2] The restoration's contour must be convex occlusally and concave gingivally in both outlines, enough to mimic the natural anatomy of healthy teeth and to ensure proper contact with the neighboring tooth.[5, 7, 8] That's why it is important that the contour is not too convex, concave, or flat, but just right for making and keeping contact with the neighboring tooth.[6]

The shape and attachment height of the interdental papilla are determined by the contour of the interproximal contact relationship.[9,10] Narrow and short gingiva are typically associated with flat proximal contours. The wide gingiva, which may not fill the whole space between the teeth, is associated with point-shaped and coronally placed proximal contours.[9]

Assessment of proximal contours can be done clinically using dental floss[11] or radiographically using modified USPHS criteria

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described by Cvar and Ryge and modified by Wilson et al.[12, 13] (Table 1).

Radiographic criteria		
Proximal contour	A	Proximal contour is correct, with adequate convexity and proximal contact
	B	Convexity lightly compromised
	C	Convexity moderately compromised "Tofflemire contour"
	D	Convexity and proximal contact compromised, repair is necessary

Table 1. Assessment of proximal contours radiographic criteria.

To preserve oral health, it is critical to understand the factors that affect how to obtain a natural proximal contour. Unlike indirect restorations, direct composite restorations can make it hard to get an ideal proximal contour. We will go over the various measures used to preserve the proximal anatomy during composite resin placement.

One question that remains unanswered is, "What is the required convexity to maintain health in each tooth?" Although research is required to prove this, may a contour as convex as the pre-treatment contour or resembling the adjacent tooth contour would be favorable to maintaining health.

LITERATURE DATA

The literature on proximal contour for Class II direct composite restorations is reviewed in this paper, along with in vitro and in vivo research found through searches on PubMed, Wiley, and ScienceDirect (with no date restrictions). Each article's reference list was carefully searched for any other pertinent articles. To synthesize the variables that impact proximal contour and those that do not as well as to identify any significant limitations and gaps in the present evidence base, this paper brings out the most therapeutically pertinent findings and conclusions while highlighting any areas that need more study.

Matrix System Type

The matrix system has been shown to be the most critical factor in restoring anatomically accurate proximal contours.[14, 15] Circumferential and sectional matrix systems are the two most widely used matrix types for posterior composite restorations (Figure 1). There are already a variety of matrix systems designed especially for use with composite resin, such as those included in Table 2.

Reviewing the literature, it is found that sectional matrix systems with separation rings provide much better contours than circumferential matrix systems. This is a common finding in most in vitro and in vivo investigations contrasting different matrix types.[3–6, 16–19] Raghu et al. summarized the advantages that a sectional matrix provides in Table 3.[6]

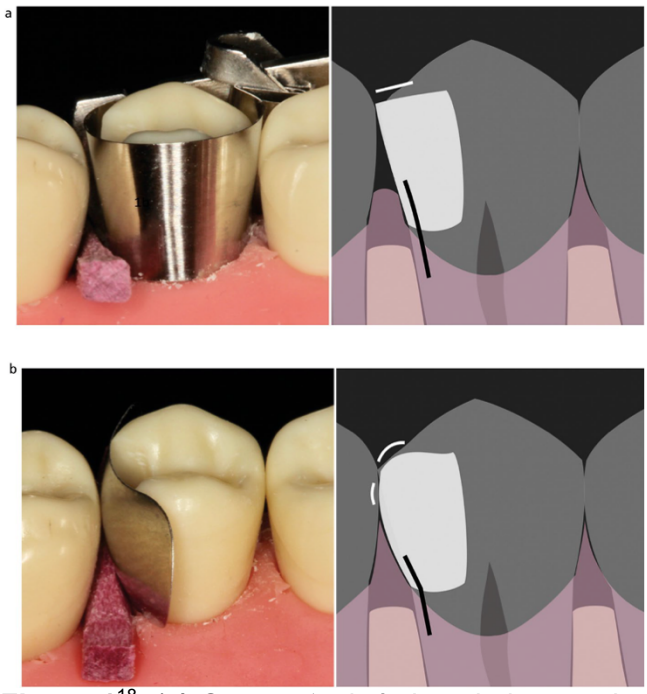

Figure 1[18]: (**a)** Contact 'point' placed above point of maximum convexity of adjacent tooth if achieved (often not). Marginal ridge laterally positioned (to maintain contact) and therefore thin, unsupported and susceptible to fracture. Embrasure flat resulting in a tendency for floss to catch and shred. Non-anatomical 'flat' cervical emergence coupled with high contact point. Tendency to interproximal dead space allowing food impaction. (Wedge position limited by matrix holder). (**b)** Contact area broader. Marginal ridge.

An in vitro study by Loomans et al. aimed to evaluate the difference in marginal ridge fracture strength in Class II composite resin restorations fabricated using a straight or contoured matrix band and various composite resins with varying moduli of elasticity.[5] In this study, two matrix systems were used (standard Tofflemire matrix system KerrHawe and Palodent sectional matrix system Dentsply) and assigned randomly to a moderate sample size of sixty artificial first molars, all mounted in a manikin model. The fracture strength was assessed using a servo-hydraulic material testing machine (MTS 858 Mini Bionix II, MTS Systems Corporation, Eden Prairie,

Minnesota, USA) with a stylus placed on the marginal ridge. The restorations were subjected to a slowly increasing force until fracture occurred. They found that the contoured proximal surfaces produced significantly stronger marginal ridges than straight surfaces.[5]

Type	Name (manufacturer, country)	Assessed or discussed in the following studies
Sectional	Palodent (Dentsply, USA)	2, 5, 7, 9, 15, 22, 24
	Triodent	3, 13, 18
	TOR VM (Moscow, Russia)	16
	Composi-Tight Gold (Garrison Dental Solutions, USA)	13, 24
	Composi-Tight matrix	7,32
	Contact Matrix System	7,24
Circumferential	SuperMat (KerrHawe, Bioggio, Switzerland)	13, 14, 22
	Precontoured circumferential matrix band system (Hawe Contoured Tofflemire Bands 1101-C, KerrHawe)	7, 15
	Caulk Automatrix (Dentsply, USA)	32
Circumferential (traditional system)	Standard Tofflemire Matrix	9, 16 ,24 ,32

Table 2. Contemporary matrix systems included in the reviewed literature.

Ease of use and good visibility
Anatomic contour of the bands ensures optimal contact areas and embrasures
Smaller tension on the teeth and greater comfort for the patient
No need for prewedging
Contact dimensions are adequate and in the correct anatomic location
Gingival adaptation of the restoration is good.

Table 3. Overall benefits with the sectional matrices and contact rings.

Sadaf et al. recently conducted a randomized controlled trial (RCT) at Qassim University's College of Dentistry in Saudi Arabia to investigate contact point optimization and proximal contour in Class II cavities using a traditional circumferential and sectional band system.[16] A total of 1200 Class II cavities in 1074 patients were randomly assigned to senior undergraduate students. There were two types of matrix systems, sectional (Palodent) and circumferential (KerrHawe Tofflemire pre-contoured metal band), with all measurements performed by the same investigator. They concluded that, as compared to the circumferential band system, the sectional matrix band with a separating ring can produce an optimal proximal contour.[16]

The usage of sectional matrices with separating rings has not been as widespread as one might expect, even though there is evidence to support their superior ability to produce a better contour. Only 10% of participants in a survey-based study by Gilmour et al. reported utilizing sectional metal matrix systems to restore occlusoproximal cavities, compared to 61% who said they used circumferential matrix systems.[20] Similar results were found in another study conducted by M.M. Awad et al., which revealed that 45.5% of participants utilized the Tofflemire matrix whereas only 32.5% employed a sectional matrix, the remaining (17.1%) utilized both matrices.[21] This could be because there is less experience with sectional matrices, and they cost more than conventional ones.

Metal and Transparent Matrix Band Selection

Clinically, metal matrices are preferred over transparent ones due to their burnishability, rigidity, thinness, and ease of placement.[15] Transparent matrices are often twice as thick as metal ones and can easily be crushed.[15] They are generally not flexible enough to adapt to the proximal surfaces.[14] In fact, the use of a thick and stiff clear matrix band in combination with a rigid light-transmitting wedge, which may impair the adaptation of the matrix band to the floor of the proximal box, may result in the creation of proximal overhangs, flat proximal contour, and open proximal contacts.[22]

Although Kampouropoulos et al. found that the metal sectional matrix causes a profound convexity of the proximal surface that strangles interdental periodontal tissue, with a transparent matrix, there is better convexity of the proximal surface.[23] These results contrast with those of Müllejans et al., who discovered that when transparent matrices were employed instead of metal ones, there was substantially more overhang development, which would compromise the proximal contour and periodontal tissue significantly more.[24]

Gomes et al. conducted a randomized controlled experiment to assess the proximal

contour of composite resin restorations carried out with various matrix systems.[4] The Tofflemire carrier matrix type (Jon, Porto Alegre, Rio Grande do Sul, Brazil), the Unimatrix sectioned metal matrix (TDV Dental, Curitiba, Paraná, Brazil), and the Unimatrix self-regulating polyester matrix (TDV Dental, Curitiba, Paraná, Brazil) were the three matrices employed in this experiment. They found that in Class II resin composite restorations, when compared to the other matrices, the sectional matrix produced a greater incidence of proper proximal anatomical contour.[4]

Sectional Matrix Band Stiffness

It is known that the use of sectional matrices is technique sensitive and must be used appropriately due to their rounded contours; sometimes it is hard to use them correctly when the contact between neighboring teeth is wide and tight without causing a depression or bending in the matrix band.[16, 17] Therefore, it is important to adopt a stiffer matrix band that can better maintain the previously contoured proximal form.

There are two types of matrix bands: flexible and dead-soft. Both consist of stainless steel, but the flexible band is more resilient and stiffer, while the dead-soft band deforms easily.[7] During manipulation, the flexible matrices exhibit elastic deformation, whereas the dead-soft matrices exhibit more plastic deformation.[25] Using flexible matrix led to less overhang, which improved the contour compared to the use of dead-soft matrices.[25]

A study by Chuang et al. that evaluated current matrices and separation systems using three-dimensional imaging unfortunately found that the thin sectional matrices provided a high incidence of concave contours.[9] On the contrary, Kampouropoulos et al. discovered that the sectional matrix leads the proximal surface to over contour.[23] In these in vitro studies, the use of a dead soft metal matrix band likely contributed to the proximal surface's uneven formation and excessive contouring with tight contact.[2]

A 50 µm hard steel matrix band may keep its optimal proximal contour better than a dead metal or soft, steel metal matrix band throughout the placement of the wedge and separation clamp.[2] A randomized clinical trial by O.O. Shaalan et al., assessing the influence of different matricing techniques in the reproduction of optimum proximal contacts, found that the use of a TOR VM sectional matrix (Moscow, Russia) with a thickness of 50 µm demonstrated ideal proximal contour in comparison to flat circumferential matrix bands.[17]

Evaluation of Interproximal Distance and Band Curvature

The precise form of the proximal contour will greatly depend on the interproximal distance between adjacent teeth at the gingival level.[6] When there is adequate interproximal clearance, both the buccal and lingual margins of the box are accessible. Passive positioning of the matrix is made possible by interproximal clearance.[2] If the matrix band cannot be passively positioned through the remaining contact, it is recommended to use a Gateway 50-m diamond strip to lighten the contact (Brasseler, Savannah, Georgia, USA).[8]

Matrix deformation, invagination, and concave contour can all occur if the matrix band is compressed into an interproximal region without adequate interproximal clearance (Figure 2).[2, 18] Additionally, it is simpler to polish and complete restorative margins that are both visible and accessible in order to produce an occlusal embrasure and a smooth buccolingual contour.[2,18]

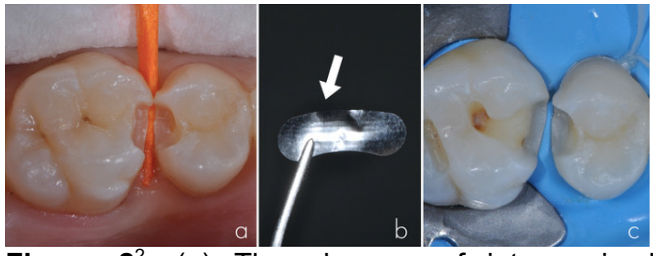

Figure 2[2]: (**a**) The absence of interproximal clearance at the buccal side interferes with passive positioning of the matrix. (**b**) The matrix is forced interproximally resulting in deformation of the matrix and inversion of the emergence profile. (**c**) Interproximal clearance is created.

The proximal contour must be more convex when the interproximal distance is greater and the clinical crown is short. When the interdental space is narrow and the clinical crown is broad, the proximal contour will be more flattened.[7] That is why the maximum curvature of the sectional matrix band must be known to select the correct one (Figure 3).[2]

The matrix band must have a greater proximal curve (cervico-incisally) as the interproximal distance increases. This happens when the margin of the cervical cavity moves to a more apical position (Figure 4).[2] The matrix band must have a greater proximal curve (cervico-

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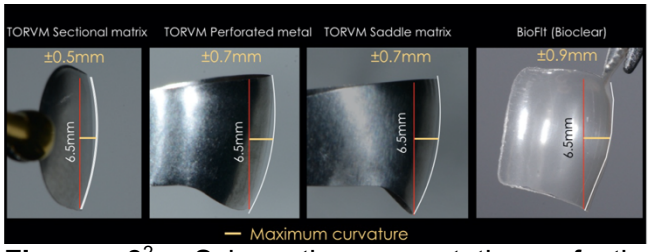

Figure 3[2]: Schematic presentation of the maximum curvature of the Sectional matrix (TORVM), the Saddle matrix (TORVM), the Perforated Contoured matrix (TORVM) and the BioFit HD matrix (Bioclear Matrix Systems). Matrix bands of 6.5 mm height were used.

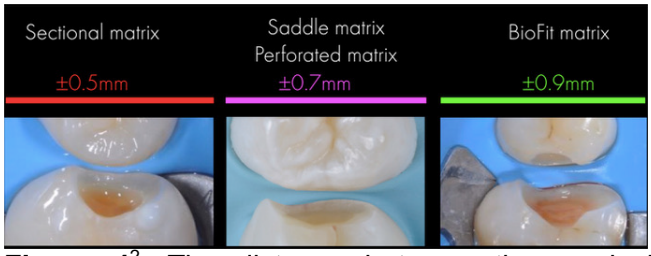

Figure 4[2]: The distance between the cervical cavity margin and the adjacent tooth largely determines the selection of the matrix band. When the space is ±0.5 mm a sectional matrix band (TORVM) is selected. When the space is around ±0.7 mm a Saddle matrix (TORVM) or a Perforated matrix (TORVM) is selected. These 3 types of hard steel metal matrix bands can be used in 90% of the class- 2 restorations. A BioFit matrix (Bioclear Matrix Systems) is selected when the interdental distance is about ±0.9 mm.

Different Types of Separation

Separation of teeth prior to restoration is accomplished by applying pressure or tension using separation rings or wedges between teeth to gain access to the lesion, acquire enough proximal contour and contact, and ease carving and finishing of the restoration.[15] It is necessary to establish a higher separation than the matrix thickness, which will permit its optimal placement. The matrix band should be placed in the interproximal space without causing any friction (with a free axis of insertion) to avoid concave contour.[2, 26]

Another possible reason for the higher incidence of a concave contour in the study by Chuang et al.[9] could be that there was not enough space between the teeth. The sectional matrix band was bent by the neighboring tooth's marginal ridge, resulting in concavity.[9]

According to a clinical study on interdental separation techniques by Loomans, specialized separation rings may be more efficient than wooden wedges when separation is needed for Class II resin composite restorations.[27] Additionally, many studies support that the use of separation rings with sectional matrices produces the best contour.[4, 6, 16, 17]

A randomized controlled trial (RCT) by Sadaf et al. found that a sectional matrix band with a separation ring provided the best proximal contour when compared to a pre-contoured circumferential matrix band system with a separation achieved by placing a wooden wedge.[16]

Another RCT by O.O. Shaalan supported these findings, finding that a small number of restorations in the pre-contoured sectional matrix group had poor proximal contours; this is likely due to either the interdental separation ring itself not being effective in teeth separation or the clinician being incapable of placing it efficiently.17

Matrix Band Height

When the sectional matrix band is placed correctly, its height should not be too much higher than the adjacent marginal ridge.[2, 8] This is about ±0.5 mm above the ridge of the adjacent tooth, to ensure the proximal surface has the proper contour on the occluso-gingival plane.[3] The operator will have good control over the positioning of the occlusal embrasure and the occluso-gingival contour if the appropriate height of the matrix band is chosen.[3]

Wedge

It is essential for a dental wedge to be able to provide resistance against the matrix and accurately conform to the anatomical contour of the tooth being restored.[2, 26, 28] Furthermore, any gap formations will develop overhangs and poor contours in the interproximal area, leading to plaque accumulation.[28] The dental market offers a wide range of wedges, including wooden, plastic, and silicone wedges.[2] The plastic wedge's design and flexibility allow them to adapt the matrix band more easily to the cervical cavity margin.[2]

A randomized controlled experiment was carried out by Gomes et al. to evaluate the proximal contour of composite resin restorations made with various matrix systems and wedges.[4] They discovered that the sectional matrix and

elastic wedge created a higher incidence of correct proximal anatomical contour than circumferential matrix and wooden wedge or polyester matrix and reflective wedge.[4]

The wooden wedge must remain below the proximal cavity floor. If the wedge remains above the cavity floor, it will cause a convexity of the matrix towards the interior of the cavity, resulting in a concave contour. In such a situation, the wedge must be customized (Figure 5).[2, 26] It also needs customization in situations where concavities are present in the proximal cervical area, such as the mesial side of the upper first premolar and lower first molar as well as the distal side of the upper first molar.[2]

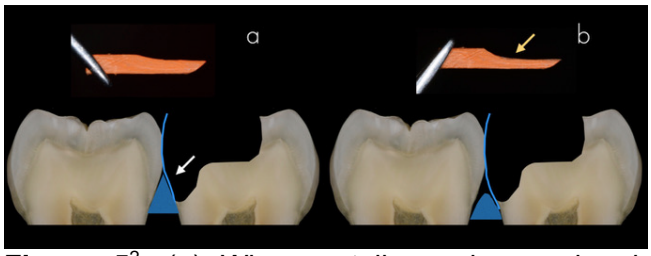

Figure 5[2]: (**a**) When a tall wooden wedge is required for fixation and adaptation of the matrix band, the wedge often comes higher than the cervical cavity margin. The wedge pushes the matrix band into the cavity (white arrow). This results in the formation of a large interdental area with increased food impaction. (**b**) After corrective trimming of the wooden wedge (=customization of wedge) (yellow arrow), the matrix band can keep its normal contour.

Adequately customized or designed wedges can assist in reproducing an imitation of natural contour in the interproximal area and ensure sufficient contact tightness with the adjacent tooth.[28] Patras and S. Doukoudakis present both the customized wooden wedge and the plastic wedge (Wave-Wedge, Triodent Limited, Katikati, New Zealand) in two different clinical cases to prevent overhang and secure ideal contours of the restoration.[28] They conclude that for the long-term success of a Class II composite restoration and the maintenance of dental and periodontal tissues, the proximal surface must be contoured properly. [28]

In a case report by S. González-López et al., they prepared an individualized wedge in the gingival embrasure prior to cavity preparation using a photo-cured resin to allow for the reproducing of proximal contours and the original contact point position.[29] It seems like an easy and effective technique. However, it needs more clinical trials to ensure its effectiveness in different situations.

Finishing procedures

As Class II composite resin restorations become more common, the inadequacy of interproximal finishing and polishing techniques is becoming a more serious issue,[30] especially with the presence of overhang, which will significantly comprise the restoration contour.

The use of burs, stones, flexible finishing strips and discs, oscillating devices (such as Roto-Pro and EVA), sonic and ultrasonic devices (such as Cavitron and Sonic Scaler), and scalpels was advised in very early papers on proximal finishing.[31] Wide strips tend to stretch too far gingivally, remove too much material from the contact points, and flatten the proximal contour.[11] This leads to a weak or missing contact and a flat contour, both of which need to be fixed.[11] Narrow sandpaper strips are specified, allowing the contour and contact point to be preserved.[32] Oscillating finishing tools are globally and effectively applicable, but coarse-grit instruments risk removing enamel, resulting in a harsh surface texture.[6] A scaler can create noticeable, large-scale fractures or crack development in the marginal region.[31]

In an in vitro study by D. Wolff et al., they developed a microscalpel whose shape can be handled in both interproximal concave and convex surface anatomy. They found that microscalpels provide easier access into the interproximal area and enable material-selective removal of composite overhang.[31]

There are numerous options available for polishing discs.[14] These may be used to smooth down the surface and are especially beneficial for marginal ridges contour, where they are less likely to harm neighboring teeth.[14]

Effects of Restorative Materials

There are contradictions in the evidence regarding the effect of restorative materials on proximal contour.

According to an in vitro study by Chuang et al., the specific matrix system, rather than the composite resin substance, had the most impact on tooth contour and, consequently, treatment outcome.[9]

In contrast, in another in vitro study done by Cerdán et al., both the contour and the contact point strength of Class II restorations of primary

molars were impacted by the restorative materials and matrix system employed.[33] The morphology of approximal surfaces repaired with two different types of resin composites revealed a wide range of proximal morphologies, and while concave surfaces were the least common, a significant fraction of flat and irregular surfaces were identified.[33] Also, they found that none of the resin composite restorations had gaps, but virtually all of them had composite excesses that compromised the contour, such as flashes and steps, which were more prominent depending on the matrix system employed. Given that these excesses are not polishable, they may have clinical repercussions.[33]

Moreover, additional studies are needed to investigate whether the composite resin material will affect the proximal contour of Class II composite restoration or not.

Conclusions

Based on the findings of this literature, a number of practical factors have been identified for obtaining the ideal proximal contour for composite resin restorations (Table 4). Using a sectional matrix system and a separation ring has been proven by studies to give greater results.

Evidence-based practical tips for optimizing proximal contour	
Sectional matrix bend over circumferential band	Good level of evidence
Use of separation ring	Good level of evidence
Metal band over transparent band	Limited evidence
Effect of wedge	Limited evidence
Effect of finishing procedure	Lack evidence
Sectional matrix bands stiffness	Lack of evidence
Effects of restorative materials	Lack of evidence
Interproximal space required	Lack of evidence
Use of contact forming instruments	Lack of evidence

Table 4. Evidence-based practical tips for optimizing proximal contour.

Even though there are clinical benefits to using sectional matrix systems with separation, they are not widely used. This could be because of their cost, the extra time it takes, or the fact that not enough people have been trained to use them. Furthermore, employing sectional matrix has limitations in some cases, such as when an adjacent tooth is missing or when there are huge cavities with significant clearance between the prepared tooth and neighboring teeth to give spring action.

The influence of the stiffness of sectional matrix bands remains debatable; however, bands that are stiffer usually keep their optimal proximal contour and exhibit elastic deformation that is easily fixed, which has been shown to improve proximal contour. There wasn't enough data to support the hypothesis that the stiffness of the band affected the Class II contour.

Very few evidences exist to support or reject the hypothesis that proximal contour is affected by the use of different types of restorative materials.

There is also limited evidence that using metal matrices over transparent material matrices may improve proximal contour.

Unfortunately, there is a lack of studies analyzing the impact of several factors that may affect proximal contour, including the adequate interproximal distance required, whether the finishing procedure can modify an unideal proximal contour, use of contemporary wedges, and whether the use of contact-forming instruments may deform the matrix band contour. Last but not least, proximal contour is just one of many things that must be considered when looking for the best proximal restoration. For successful rehabilitation of the proximal surface, there are other important factors that must be met for Class II composite restoration, including the proximal contact tightness, the position and size of the contact area, accurate marginal ridge placement, and adequate marginal adaptation. All of these factors can be improved with knowledge and practice.

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Declaration of Interest

The authors report no conflict of interest.

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