ADA VICTORIA

CLINICAL UPDATE QUIZ
February 2025

Impact of matrix systems on proximal contact tightness and surface geometry in Class II direct composite restoration in-vitro

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Background

Class II direct composite restorations in posterior teeth require tight, anatomically correct proximal contacts to prevent issues such as food impaction, tooth migration, and caries. Improper contact can also lead to periodontal damage if excessively tight or loose. Effective restorations involve both adequate proximal contact tightness and correct contour formation. Several techniques such as using high-viscosity composite, separation ring systems, and pre-contoured matrix bands aim to enhance contour and tightness. The matrix system itself has a significant effect on the success of these restorations. Sectional matrices combined with separating rings are the gold standard in achieving reliable contact tightness; however, they may lead to a concave morphology at the contact area. Traditional circumferential matrices often have limited success in forming tight contacts and anatomic contours. The recently introduced Palodent 360 circumferential matrix system offers pre-contoured, thin bands with an integrated tightening mechanism, designed for ease of use and efficient restorations with optimal contouring. This study aimed to evaluate whether the Palodent 360 system provides comparable proximal contact tightness and contour quality to the sectional matrix system with separation rings.

Methods

Sample Preparation

The study included 20 standardized mesio-occlusal cavities on Nissin typodont lower right first permanent molars. Cavities were prepared with specific dimensions (4 mm buccolingually, 3 mm occlusogingivally, 1.5 mm mesiodistally, and 1.5 mm occlusopulpally) to ensure consistency. The molars were randomly divided into two groups of 10. Group 1 used a sectional matrix system with a separation ring (Palodent V3, Dentsply Sirona, USA), while Group 2 used the Palodent 360 circumferential matrix system, which has an integrated tightener.

Restorative Procedure

Both groups used pre-contoured matrix bands (5.5 mm in height, 0.032 mm thick). In Group 1, the sectional matrix band was placed on the mesial surface of the cavity, with the separation ring positioned interproximally. In Group 2, the circumferential matrix was positioned around the tooth and tightened using its built-in mechanism. Anatomic plastic wedges (Palodent V3 Plus Wedge, Dentsply Sirona, USA) were used in both groups to secure the gingival margin, and no additional burnishing was applied for standardization.

Following cavity preparation, adhesive was applied according to the manufacturer's directions and cured for 10 seconds using a light cure unit. Tetric N-Ceram nano-hybrid composite was placed in three incremental layers, each cured for 20 seconds. The procedures were performed by a single operator to minimize variation.

Evaluation of Proximal Contact Tightness

Proximal contact tightness was measured using a universal testing machine (Instron model 3345). The machine exerted maximum frictional force (N) on a 0.05 mm-thick stainless-steel strip during its withdrawal from the interproximal area, simulating the force needed to pass dental floss through the contact area. The maximum force, expressed in Newtons, was recorded as the measure of contact tightness.

Analysis of Restoration Proximal Contour

Each restored tooth was examined for surface concavity at the contact area. Concavity was assessed by measuring the cross-sectional area, depth, and radius of curvature using a contact stylus profilometer.

Statistical Analysis

Data were analysed using the Statistical Package for Social Science (SPSS) software. Quantitative data were presented as mean and standard deviation, and group comparisons were conducted using an independent sample t-test. A p-value of ≤ 0.05 was considered statistically significant.

Results

The sectional matrix group showed significantly tighter contacts than the circumferential matrix group, with a mean tightness of 4.22 ± 0.90 N compared with 3.03 ± 0.39 N, respectively ($p = 0.002$). Both groups displayed concavity at the contact area.

However, the circumferential matrix group had a significantly larger concavity area (0.16 ± 0.06 mm^2) and depth (0.11 ± 0.03 mm) than the sectional matrix group, which had an area of 0.03 ± 0.03 mm^2 and a depth of 0.05 ± 0.04 mm ($p < 0.001$ and $p = 0.001$, respectively). In terms of curvature, the sectional matrix group had a greater radius of curvature (9.48 ± 4.48 mm) than the circumferential matrix group (5.80 ± 2.24 mm), a statistically significant difference ($p = 0.036$).

Discussion

Tight proximal contacts with anatomically correct contours play a crucial role in maintaining dental arch integrity and periodontal health. Effective reconstruction of the proximal surface depends largely on the shape of the matrix band and its precise placement. Sectional matrix systems, which include a pre-contoured matrix, separating ring, and wedges, are widely regarded as the standard for increasing contact tightness and achieving anatomical morphology. Circumferential matrices often fall short in contact tightness and anatomical contouring.

The Palodent 360 circumferential matrix system tested in this study offers advantages in ease of use and workflow efficiency due to its single-component design. However, in two-surface cavities, where the matrix must pass through an intact contact area, it was observed to create looser contacts than the sectional matrix. Additionally, no separation rings were used with the circumferential matrix, which likely contributed to reduced contact tightness.

Concavities in proximal restorations can compromise clinical outcomes, as they may trap biofilm and increase caries risk on adjacent teeth. Similar to contact tightness, the shape and concavity of the contact area are directly influenced by the matrix-retainer system. The circumferential matrix group demonstrated a significantly larger and deeper concavity than the sectional group. Prior research has indicated that the circumferential flat matrix and Tofflemire retainer often create noticeable concavities due to the use of a thicker matrix band. In this study, the circumferential matrix with a thin, pre-contoured band and integrated tightener was used, yet concavities still occurred, suggesting matrix deformation at the contact area during placement as a contributing factor. Such distortions may be due to contact with adjacent teeth during matrix placement or insufficient rigidity of the matrix band. Peripheral and central deformations can also arise from the separation ring's tendency to "tent" the matrix, creating peripheral gaps and dimpling the contact area against adjacent teeth. Excessive pressure during composite application can further distort a less rigid matrix.

The study focused on mesio-occlusal surfaces to ensure standardization, which may be a limitation, as MOD cavities with two rings and wedging could produce different outcomes.

Conclusion

Sectional matrix systems with separation rings were shown to provide superior contact tightness over circumferential matrix systems like the Palodent 360. Both systems exhibited some shortcomings in achieving ideal proximal contours for Class II resin composite restorations. For improved outcomes, clinicians may consider using more rigid matrix bands or combining circumferential matrices with separation techniques, such as rings or pre-wedging.

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Questions:

1. What is one potential adverse consequence of a loose proximal contact in Class II restorations?
   a) Increased tooth migration
   b) Enhanced periodontal health
   c) Decreased caries risk
   d) Improved flossing accessibility

2. Which matrix system is considered the gold standard for establishing strong proximal contacts?
   a) Circumferential matrix with integrated tightener
   b) Sectional matrix with separation ring
   c) Palodent 360 circumferential matrix
   d) Flat circumferential matrix

3. What unique features does the Palodent 360 matrix system offer?
   a) A separate ring component
   b) Pre-contoured thin bands and an integrated tightening mechanism
   c) Stainless steel reinforcement
   d) Non-stick coating on internal surface

4. How was contact tightness measured in this study?
   a) With visual inspection
   b) By tensile force applied with a universal testing machine
   c) Using dental floss pass-through
   d) Contact stylus profilometer

5. In terms of proximal contact tightness, which group showed superior results?
   a) Circumferential matrix group
   b) Sectional matrix group
   c) Both showed similar results
   d) Results varied by cavity size

6. Which of the following was more pronounced in the circumferential matrix group?
   a) Radius of curvature
   b) Depth of concavity
   c) Contact tightness
   d) Gingival margin accessibility

7. What was the depth of concavity in the sectional matrix group?
   a) 0.03mm
   b) 0.05mm
   c) 0.11mm
   d) 0.16mm

8. What was a limitation in this study?
   a) Only MOD cavities were studied
   b) The study focused on mesio-occlusal surfaces only
   c) No adhesive was used
   d) Cavity dimensions varied significantly

9. How might insufficient matrix band rigidity affect restoration?
   a) It can increase contact tightness
   b) It leads to distal migration
   c) It causes deformation, impacting contour quality
   d) It enhances floss accessibility

10. What overall improvement did the study suggest when using circumferential matrices?
   a) Using adhesive-coated bands
   b) Adding rings or pre-wedging for tighter contact
   c) Avoiding their use in Class II restorations
   d) Opting for thicker matrix bands

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