



A Historical Review of Dental Matrices

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ABSTRACT

In dentistry, matrix bands play an essential role in restoring interproximal surfaces of the tooth. Their use has long been advocated to produce a satisfactory proximal surface of restorative materials. This paper reviews the history, types, selection and use of the matrix bands/ systems which is significant in both the quality and longevity of the final restoration.

Key Words: Matrix band, Matrix system, Matrix retainer, Class II restoration, Mould.

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INTRODUCTION

MATRIX BANDS

A matrix is defined by the Oxford English Dictionary as a mould in which something is cast or shaped, or as a place in which a something is developed.¹ The Glossary of Prosthodontic Terms Sixth Edition defines matrix as a mould or impression in which something is formed.² Clinically, it may be defined as a thin strip adapted around the tooth to supply missing walls and contours against which restorative material may be placed and condensed. Rutsky states that the matrix band is the most crucial factor of the success or failure of a proximo-occlusal amalgam restoration. Overhang of an amalgam restoration may result from the failure of proper adaptation of the matrix band to the external surfaces of the tooth.³

1. Requirements of ideal matrix

The matrix band should be rigid enough to maintain its position during condensation. Amalgam is a strong and durable restoration material that must be condensed forcefully into a space retained by rigid walls, such as those that can be achieved by the use of a matrix band. It is useless if the matrix band yields during placement and condensation; crystallization is disturbed and weakness results in the material. Consequently, adequate condensation cannot be achieved leading to porosity of the material. Rigid or unyielding matrix bands support the restoration during building and defining contour

on the surfaces by means of proper adaptation to the tooth surfaces.^{4,5} The proximal surface should be anatomical and conform to the convexity of the marginal ridge of the tooth but not in such a way that the health of gingival tissues will be jeopardized. It is desirable to have a rigid but flexible matrix band. Flexibility of the matrix band allows for burnishing of the contact area to a degree that can be controlled by the operator.^{5,6} Contouring the proximal surface minimizes or eliminates the need for carving.

An intimate adaptation of the matrix band to the gingival margin results in sealing of the tooth-restorative interface.⁶⁻⁸ The interproximal use of wedges aids in limiting the spaces between the tooth and the matrix band at the gingival margin. Failure to eliminate this space would increase the chances of overhangs incidence on final finish. The careful selection of the correct size and shape of wedge (better viewed in cross-section dimension) is important.

Oversized wedges may force the matrix from its contact position. The matrix band must be tightly wedged at the gingival margin in order to prevent the matrix becoming loose and moving and sliding during condensation of the restoration material.

The matrix band must be easy to apply and withdraw without distorting the amalgam. Disruptive friction-induced vectors may fracture away a part of the marginal ridge mass or may encourage a future fracture. The path of withdrawal

should be resisted by the tooth surface such as the buccal wall of the cavity. It should be withdrawn bucco-lingually whenever possible to avoid disturbing the contact area.⁶⁻⁸

Thickness of the matrix band influences the interproximal contact area of the restoration. The band material should be thin enough so that proper contact can be established. Usually, when the matrix band is removed from the interproximal area, it generates a contact void as wide as the thickness of the matrix band. Separation by wedging interproximally would compensate for this space. The thinner the matrix band, the less wedging is required. The space between the filling and an adjacent tooth should be kept to a minimum. However, the rigidity of the matrix band should be maintained to resist yielding during placement and condensation procedures. Stainless steel as thin as 0.0015 or 0.0020 inches can be used; it is still hard enough to allow for burnishing to contour the band. The degree of smoothness of the matrix band surface offers two great advantages to the matrix system. First, the smoothness of the band enhances the surface quality of the finished restoration and results in the area being less plaque retentive. During removal of the matrix band, less disruptive friction will be developed and the marginal ridge height will be maintained.

The matrix band should be capable of being sterilized, compatible with other restorative materials, and non-toxic. It should be reasonably economical.

2. Function

A matrix band well adapted to the contour of the tooth surfaces serves several functions. Matrices provide the missing wall(s) of the prepared box of the cavity preparation so that adequate condensation forces can be applied. The matrix band retains the restoration during placement and condensation, in addition, it also maintains the amalgam during initial stages of setting.^{9,10} Definitive restorations thus produced appear to be stronger if the internal air spaces or marginal deficiencies are eliminated, this can be achieved by proper condensation of the restorative materials. If a matrix is not used, condensation will tend to push the amalgam out of the preparation. In other ways, matrix bands restrict extrusion of the amalgam and

formation of overhangs at the interproximal margin.

Properly contoured matrix bands allow restoration of interproximal contact areas with adjacent teeth and proper external crown contours as well as the establishment of the marginal ridge height. Interproximal contact areas and external crown contours are also determined by the amount of separation provided by the wedge. Proper wedging gives sufficient separation thus allowing more effective condensation and placement procedures and will result in adequate interproximal contact areas. Matrix bands also provide adequate physiologic contour for the proximal surfaces of restorations and create an acceptable surface texture to the area where it cannot be carved or burnished. Finally, they will also protect the periodontal tissue from damage and prevent the development of overhangs apical to the gingival floor.¹⁰

3. Type of matrix available

From the early 18th century, many types of matrices have been introduced for clinical use. Some of the earlier matrices are no longer available. However, certain matrices may be more suitable for a particular application than others. Therefore, familiarity with the wide range of matrices available is desirable. Matrices can be divided into three main categories; custom made: preformed or mechanical.⁵

3.1. Custom made

a. Black's tie band

A Black matrix is one of the earlier custom-made matrices, known as a "ligated matrix band". A thin metal plate of, for example copper, brass, German silver, or stainless steel can be used as a matrix. The selected matrix band is adjusted to a sufficient width to cover from the occlusal surface to the gingival margin and must be of sufficient length to encircle about half of the tooth. This thin matrix band is placed at the proximal surface of the tooth. Then the ligature is wrapped tightly two or three times around the tooth, including the matrix band and tied. After the desired separation has been achieved, the matrix should be contoured to the shape of the proximal surface then finished by a burnisher.

b. Compound and wedge-supported

In 1937, Hollenback modified Black's matrix by using low fusing modeling compound to support the band prior to placement of amalgam. The matrix was so securely held that it would not yield even when heavy condensing force was used.⁹ Hollenback stated that any matrix that would yield was unfit to use.⁹ Later in 1940, Sweeney explained how important it is to have matrices that are rigid and as well as immovable to prevent slide of the matrix and the restoration. In order to achieve the criteria above, Sweeney used 0.002 inch untempered steel matrix material, contoured according to the proximal surface, and supported with a water-softened wooden wedge made from an ordinary tongue blade.¹² The wedge was triangular in shape.

The triangular base had to be carved to fit tightly to the gingival margin while the apex of the triangle ended just beneath the contact point of the opposing tooth. The matrix was contoured and adapted to extend 1 mm above the adjacent marginal ridge coronally and apically beyond the gingival margin of the cavity preparation. The matrix was then supported with a green compound that was first softened and inserted into the buccal and lingual embrasure area and the pressed until it hardened. The compound reinforced the band forming the contours anticipated for the finish filling. Ivory no 1-matrix retainer jaws were warmed and pressed into the reinforced compound. By doing this, the compounds from buccal and lingual surfaces were secured to the adapted position.¹²

In 1955, Ingraham and Koser postulated four requirements of a successful Class II amalgam restoration.¹³ First, the restoration should have proper contour that conforms to the natural contour of the tooth as well as proper contact points with the adjacent tooth, correct marginal adaptation, and lastly, sufficient density of restorative material. These requirements can be best met by utilizing a non-yielding anatomic matrix. This is the same matrix advocated by several authors mentioned above. The only difference was that instead of using Ivory no 1-matrix retainer, Ingraham used a wire staple of proper width constructed from a metal paper clip. The height of the staple must be shorter than the crown of the tooth. The staple is then heated and forced into the buccal and lingual compound thus giving additional stability to the matrix by locking the two pieces of

compound together. Burnishing with a heated ball burnisher then further modifies the band. Ingraham mentioned that mechanical types of matrices encountered a few problems such as the tendency to lose marginal adaptation because of stretching of the band during condensation, the possibility of marginal excess or overhang, loss of tooth contour, and improper positioning of the contact areas.¹¹ The accurate placement of the anatomic matrix eliminates the problems encountered by using mechanical types of matrices, and reduces the rate of failures and the finishing time for the restoration. The disadvantages of the anatomic matrix are that it is difficult and time consuming to apply.¹³

c. T-band

In the early 1970s, T-bands gained popularity for multi-surface amalgam restorations, preferably class II restorations.¹² They can be used if the adaptation of a conventional matrix faces some difficulties. This matrix is available in curved or straight brass or stainless steel and also in wide or narrow sizes.^{5,8} The T-band is not difficult to apply, does not require additional instrumentation, and is reasonably economical.

Bailes in 1944 used 1.5 inches long and 0.002 thick matrix band to construct this band. The band is carried to the tooth by matrix-forming pliers, the band encircles the tooth tightly. Once the proper size has been achieved, the band is removed from the tooth. The bent parts of the band are coated with soldering flux and are held together by tweezers' beaks. The band is then held over the flame. When the solder has softened and the joint is tight, the solder is dipped into water. Any solder can be used for this purpose.¹⁵



Figure 1. Palodent matrix

d. Tinner's joint

A tinner's joint may be used to join the matrix material if a spot welder is not available. The band is first tightened around the tooth. One of the two free ends is cut shorter than the other. The longer end is then folded over the shorter end, and both are folded again in the same direction. The folded joint is pressed tightly with pliers and the band is contoured and positioned on the tooth.

3.2. Preformed

a. Sectional

Another type of matrix that is available for clinical use is the preformed sectional matrix utilized in conjunction with the Palodent TM matrix. The matrix band is precut and precontoured. The Palodent matrix uses a two-tined split ring for retention of this matrix. This matrix is easy to apply. First the matrix is positioned interproximally and wedges are used to secure the band to that position. The two-tined ring is spread with a rubber dam clamp holder and warm modeling compound is placed on the tip of the ring. Then the two-tined ring is applied to the buccal and lingual embrasure areas. The proximal surface of the matrix is then ready to be burnished to enhance the contour and contact of the restoration. This type of matrix is not suitable for multisurfaces or complex restorations. In the case of MOD restoration, two matrices can be used independently and supported by two Palodent rings on each side. Even though it is easy to apply and inexpensive, Palodent rings might be in the way of the operator and more time is needed for placement and condensation of the restorative material.



Figure 2. Automatrix TM L.D. Caulk Co

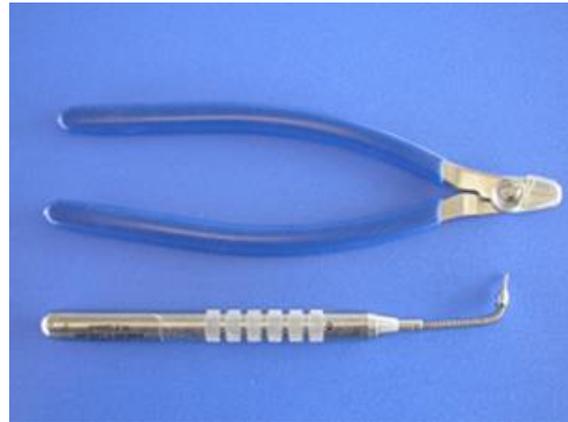


Figure 3. Automated Wrench and Cutter

b. Circumferential

Preformed circumferential matrices are more useful for badly broken down teeth or more precise for complex restorations. The operator must first select the closest band that fits the cervical margin of the tooth. Once the proper size band has been selected, the band is annealed by heating then quenching in water. The proximal contact area should be thinned by stone or disc to allow better contact. The buccal surface is scored with a disk, making it easier to cut with a knife and pull apart to facilitate withdrawal. Lastly, the band is festooned and contoured with contouring pliers before it is placed. Additional stability and support can be facilitated with wedges and/or modeling compound. This type of band is left in place until the amalgam has hardened completely.

c. Automatrix

The Automatrix TM or retainerless matrix by L.D. Caulk Co. Milford, Del is a type of individual matrix that does not require a separate retainer to attach it to the tooth. This matrix has been available since 1977 and can be an alternative to using a seamless copper band or any custom made matrices. It is also less time consuming. It can be placed on the tooth more easily than a copper ring and can be placed in many positions on the tooth. The most important advantages are that this matrix band is a quick method and simple to remove and there is a small risk of fracturing the marginal ridge. Winstanley in 1977 stated that although it can be used for most teeth, it does not appear to have any obvious advantages over other types of matrices for cavities of conventional size other than reducing bulk in the mouth. By using this matrix, a mutilated tooth that

requires complex restoration can be restored with satisfactory results. For large cavities, this matrix will not encroach on the cavity and results in a normal contour of the restoration. This criteria makes automatrix superior for treating complex restorations.¹⁶



Figure 4. Siqueland Matrix Retainer

There are four types of Automatrix TM that are available for selection: wide regular, medium regular, narrow regular, and medium thin. The band has a coil of excess material at one side for tightening. There is a loop that is cut off upon removal of the band. This section of the band facilitates the process. Once the matrix band is placed on the tooth, the automated wrench supplied in the kit is inserted into the coil and then rotated. The wrench is tightened until it clicks. Then the wrench is rotated counterclockwise to release it from the coil. Wedges should be placed to enhance stability of the matrix band and lastly, an explorer is used to verify the matrix adaptation to the tooth.¹⁷ There is also a small hole close to the coil where the tip of an instrument can be inserted to ease the removal.

3.3. Mechanical Retainers

a. Ivory no 1

This mechanical retainer has been available for many years and it is useful for Class I or unilateral restorations. The idea of this matrix owes its precedence to the operators of gold foil.¹⁸ This retainer holds the stainless steel band that provides for the missing wall for single proximal surface restoration. The matrix band is shaped by the manufacturer is allow placement in deep proximal boxes. There are four square holes at the end of the

matrix band that allow it to be secured onto two diamond-shaped projections on the adjustable calliper arms of the retainer and adjusted for size. Once a matrix band is placed on the tooth and wedges are in the right position, the retainer can be adjusted. This matrix requires more time because of difficulty during its application. The main advantage of this type of matrix is that it will work when a circumferential matrix cannot be used especially in restoring a cavity where the contact is too tight for a circumferential matrix, or in the case where no adjacent tooth is present.^{5,8}

b. Circumferential

Most circumferential mechanical matrices require a retainer to hold, adjust, and withdraw the matrix. Ivory no.8 or no.9, Siqueland, Wagner and Tofflemire can be used for this purpose.



Figure 5. Siqueland Matrix Band

1. Wagner

Green in 1943 stated that the Wagner matrix retainer is commonly used for restoring complex cavities. The major problem with this retainer is that during withdrawal from a tight matrix, the contact with the adjacent teeth may be lost.¹⁸

2. Siqueland

The Ash® Siqueland Matrix Clamp is a self-adjusting, simple to operate, band retainer, suitable for use on all teeth. For the best results and to avoid gingival ledges and overhangs, the wedging of matrix bands is always recommended. The Siqueland retainer was invented to minimize the problems encountered with the Wagner matrix. A Swivel lock is incorporated into this retainer that permits a withdrawal of the band securely at the gingival third

of the tooth.¹⁸ This type of matrix retainer is commonly use in the U.K.

3. *Tofflemire*

The main advantage of this system is that the band can be placed either lingually or buccally and it can be adapted in straight or contra-angle styles, and in regular or small sizes.^{5,8} It consists of four parts that are head, slide, rotating spindle and set-screw. The head is the part that has an open side. Usually at this side, there are two slots where a matrix band can be position. The slide is the part that slides where brought close to the head for band installation. The rotating spindle is use to adjust the distance between the slide and the head. Finally, the set-screw locks and unlocks the matrix band in the slide. Once the matrix is attached to the retainer, it then can be placed on the tooth. It should not fit too tightly or the contour and contact will be lost. The main disadvantage is that the contact surface is usually located incorrectly near the marginal ridge leading to an abnormal embrasure space and unnatural look.

Stainless steel Tofflemire type matrix bands are available in two thicknesses; 0.0015 gauges and 0.0020 gauges and in four styles per thickness. Stainless steel Tofflemire type retainers can be used with any width band. A Tofflemire type retainer locks securely, releases instantly, and adjusts easily. The bands include flat bands of different shapes, precontoured bands and bands with or without memory (dead-soft metal). Clear matrix bands are also available for use with Tofflemire retainer, but may deform if firmly tightened and may cause a defective restoration.



Figure 6. Tofflernire Matrix Retainer



Figure 7. Tofflernire Matrix Band

4. *Dentatus*

This type of matrix retainer is quite similar to Tofflemire matrix retainer.

5. *Omni*

The Omni-Matrix TM from Ultradent is a disposable matrix retainer with pre-loaded band. The product consists of a single-piece, plastic, lightweight retainer loaded with a 0.002" mylar bands or metal band. The metal bands are available in two thicknesses: 0.0015" and an "ultra-thin" 0.001." A 0.0015" pedo size metal band that is about 1-mm shorter than the other bands is also available pre-loaded in a separate retainer. The four retainers have color-coded knobs to make it easy for the users to know which retainer/band combination they are using.

4. Requirements for matrix retainer

A good matrix retainer should be easily applied and fixed in position. A sufficient amount of separation is usually needed to compensate for the thickness of the matrix band and also to allow for application of reinforcements such as modeling compound or plaster if necessary. Finally, the matrix retainer should allow the band to be adapted and contoured properly and it must be easily removed. Unfortunately, mechanical matrices are insecure and frequently are moved by patient's lips or tongue. The retainer is usually in the way of operator and definitely annoying to the patient.¹⁵

CONCLUSION

With increasing emphasis being placed on precision of interproximal restoration the importance of the marginal adaptation must be stressed. ASSD and

matrix band have a major role in creating margin of the restoration especially at gingival margin area. Improper placement of matrix and wedges can result in poor contours or contacts, overhangs or weakness resulting from poorly condensed restorative material. Further research is necessary to determine the ideal materials or instruments or their combination for this purpose.

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