

**COMPARATIVE EVALUATION OF CONTACT AND
CONTOURS IN CLASS II COMPOSITE RESIN
RESTORATION IN MOLAR TEETH USING TWO MATRIX
SYSTEMS: A RANDOMIZED CLINICAL TRIAL**

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LIST OF ABBREVIATIONS



| Sr. no | Abbreviations | Full form |
|--------|---------------|---------------------------------------------------|
| 1. | USPHS | United States Public Health System |
| 2. | DMF | Decayed (D), missing (M), or filled (F) |
| 3 | DMFT | Decayed (D), missing (M), or filled (F) Teeth (T) |
| 4. | PCS | Proximal contact strengths |
| 5. | FRC | Flowable resin composites |
| 6. | RMGIC | Resin modified glass ionomer cements |
| 7. | µm | Micrometer |
| 8. | MOD | Mesio-Occlusal-Distal |
| 9. | PCT | Proximal contact tightness |
| 10. | p value | Probability of happening of an event |
| 11. | Mm | Millimeter |
| 12. | RCR | Resin composite restorations |
| 13. | MO | Mesio- occlusal |
| 14. | DO | Disto-occlusal |
| 15. | RVG | Radiovisiography |
| 16. | N | Number of specimen in each group |
| 17. | SD | Standard Deviation |
| 18. | LED | Light emitting diode |
| 19. | FDI | Fédération Dentaire Internationale |
| 20. | CAT | Contact area tightness |
| 21. | i.e. | That is |
| 22. | S | Significant |
| 23. | NS | Not Significant |
| 24. | No. | Number |
| 25. | St | Sound teeth |

INTRODUCTION

INTRODUCTION

"Nature has done her best in the way of making an anatomic arrangement to avoid trouble; it's for the dentist to assist the nature by copying this arrangement in the best possible way, when he attempts to make fillings on the proximal surfaces."

- *C.N.Johnson*

Teeth are complex anatomical units owing to their structure and properties. Every tooth in human dentition has its own anatomic contour and specific relationship with its supporting structure, adjacent and opposing teeth.¹ Tylman commented on the contact points and wrote that the form of a contact point and the area in which it is placed, both buccolingually and occlusogingivally is extremely important for a perfectly equalized arch.² Proximal contact areas are areas on proximal surfaces of tooth crowns, where a tooth touches the adjacent tooth when teeth are in proper alignment.

This area preserves the stability and integrity of arch by maintaining normal mesio-distal relationship of teeth and also prevents interdental food impaction. Proximal contact area allows normal healthy interdental papilla to fill the interproximal spaces.³

Herbert and Vale stated that each tooth has a danger area just below its proximal contact point where food can stagnate. This is the starting point of interproximal caries. The size of the contact point or area, and the shape of the embrasures to a great extent influence the susceptibility to the caries attack.² Interproximal caries develops between the contacting proximal surfaces of two adjacent teeth. It also annihilates the normal tooth form, which impedes the main function of the tooth such as mastication.

Optimizing tooth form has always been the “holy grail” of restorative dentistry. Recreating the missing tooth anatomy is important not only to replace the lost tooth structure but also to re-establish the ideal form and function.³ Over a century, dental amalgam has successfully served the profession in restoring the proximal caries. It has been replaced by other restorative materials because of adverse health effects and inferior esthetic appearance.⁴ Packable resin composites are considered as a resin based amalgam substitute with sufficient physical properties to withstand posterior occlusal forces & its ability to conserve the tooth structure. According to the manufacturers, packable resin composites can be placed in bulk, have less polymerization shrinkage, decreased microleakage, and increased fracture toughness and wear resistance compared to traditional hybrid composites.⁵

Clinically, one of the greatest challenges encountered by the most experienced clinicians when placing Class II resin composite restorations is creating tight proximal

contacts and obtaining anatomically correct proximal contours.⁶ Improper establishment of tooth anatomy i.e. the proximal contact point, contour and the marginal ridge of the tooth leads to premature failure of restoration, compromised periodontium and secondary caries. Improper restoration in the contact area will also cause displacement of the teeth, lifting forces of the teeth and rotation of the teeth.³

Various techniques have been developed to achieve better proximal contacts and contour, including the use of special devices to provide more effective tooth separation. Matrix system was first introduced in dentistry by Dr. Louis Jack in 1871.⁷ They are the special devices advocated to produce a satisfactory proximal surface of restorative materials. 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.⁸ Traditionally, matrix bands were manufactured from thin, flexible, flat pieces of metal and were placed circumferentially around the affected tooth. Ideal requirement for all matrix and retainer systems include stability on band insertion and exhibition of adequate style (flat and precontoured) and width (adequate thinness to account for the space taken by the restorative material) for the reconstruction of correct proximal contours and contact surface.⁷

Most frequently used matrix band systems are Ivory and Tofflemire matrix bands and retainer. Ivory matrix system is an adjustable metal retainer, holds bands of stainless steel that provide the missing wall for the single proximal surface, but this band does not adapt sufficiently close to the occlusal portion of the proximal margins, when the retainer is tightened, whereas Universal retainer designed by B.R tofflemire is a versatile instrument but still does not meet all the requirements of the ideal retainer

and band.⁸ In order to overcome these drawbacks newer systems have been introduced such as Automatrix, Sectional contoured matrix system and Saddle contoured matrix etc.

Sectional contoured matrix one of the type of Palodent system includes a kit of sectional matrix with double convexity which are fastened in the adequate position with help of BiTine rings. The anatomical contour of the matrix band that helps in obtaining proper proximal contact and embrasures, good visibility of the operating field and greater comfort for the patient due to less tension on the tooth are some of the advantages of this system.⁹

Saddle contoured matrix system is an autoclavable stainless steel, anatomically pre-shaped matrix system. According to the manufacturer, it has a superior high tensile strength and it provides a perfect approximal form & contact. It has a spring clip holder with a matrix band which helps in placement of matrix band on to the tooth.

Various in vitro studies have been done on automatrix, omni matrix ,V3 sectional matrix systems.^{10,11} **Loomans et al 2009** compared in vitro interproximal overhang formation of Class II composite resin restoration using different matrix systems and concluded that sectional flexible matrices resulted in the least marginal overhang when combined with a Contact Matrix separation ring or a Composi-Tight Gold ring.¹²

To best of our knowledge no study has been done in vivo to compare these two matrix systems i.e. sectional contoured matrix system and saddle contoured matrix system. Thus, the purpose of this study was to evaluate and compare the contact and

contours achieved in class II composite resin restoration in molar teeth using two matrix systems.

The null hypothesis evaluated was that no difference would be present in the contact and contours achieved in class II composite resin restoration with respect to the both matrix systems used.

AIM AND OBJECTIVES

AIM & OBJECTIVES

AIM:

To evaluate and compare the proximal contact and contours in class II posterior composite restorations achieved with Sectional contoured matrix and Saddle matrix.

OBJECTIVES:

1. To evaluate the interproximal contact and contour in selected molar teeth preoperatively.
2. To evaluate the interproximal contact and contour in class II composite restorations with the Sectional contoured matrix in molar teeth.
3. To evaluate the interproximal contacts and contour in class II composite restorations with the Saddle matrix in molar teeth.
4. To compare interproximal contact and contour in class II composite restorations in molar teeth done with Sectional contoured matrix and Saddle matrix.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Re-establishing a good proximal contact and contour is one of the goals of restorative dentistry. A good proximal contact and contour is important for the prevention of the food impaction, tooth migration, periodontal complications and carious lesions.¹³ Posterior composite resin introduced in late 1980's , created a set of restorative problems such as open margins, open contacts and overcontoured or undercontoured restorations etc . The current strategies for management of these problems is based on evolution of composite matrix system combined with the knowledge and understanding of the clinician. Therefore it is essential to review the literature regarding various matrix systems and its techniques that have been evolved over the years for longevity of composite restorations.

The evolution of matrix system has been introduced since early 1800 century for clinical use. The Jack matrix, introduced in 1871, was accepted as the first matrix to satisfy the concept of contoured fillings. The matrix consisted of a slightly wedge-shaped piece of steel hollowed out to create a depression on its face to correspond to the desired contour. Later, an improved version called the Depressed matrix was introduced. The band of this matrix was thinner at the cervical aspect and curved from end to end to provide more access to the cavity.¹⁴

The Huey matrix was introduced about 1874 as an improvement on the Jack matrix. The design included a circumferential band and thus the matrix could be used for both two-surface and three-surface restorations.¹⁴

The Perry matrix introduced in the late 1800s, was used for two-surface restorations and depended on a mechanical separator, the Perry separator, which improved the amount and method of separation (Brophy, 1886). The matrix consisted of a band of thin, narrow brass or phosphor-bronze. The band could be shaped before placement and was burnished to the adjacent tooth for re-establishment of the tooth's contour and contact. Black (1899) modified this design of matrix by using bands of copper, German silver, or steel. He also placed a wedge of softwood into the lingual embrasure if close adaptation at the cervical margin were required.¹⁴

The Brunton matrix which also was introduced in the late 1800s occupied one interdental space but did not require the adjacent tooth for retention. This matrix consisted of a band made of a short piece of clock spring with the temper taken out of

the ends. Cunningham (1885) modified this matrix by using a band of platinum foil secured with a rubber dam clamp.¹⁴

Custom matrices was introduced in the late 1800s. The custom matrices consist of a band in conjunction with some type of separating device other than a mechanical separator. Three types of custom matrix are used currently: the anatomic matrix, the tie-band matrix, and the continuous-loop matrix. Anatomic matrices include Shellac Matrix , Woodward Matrix, Herbst matrix, Hutchinson matrix, Hand matrix, Rubber matrix, whereas Tie band matrix includes Perry, Clapp, and Fillebrown matrices. Continuous-loop matrix differed from the anatomic and tie-band matrices. It was introduced for cavities involving three or more surfaces. The early matrices of this group include the Herbst continuous loop, collar, or band and the Weirich matrix of a single band of metal alloy.¹⁴

Miller matrix in 1885, was introduced that consisted of a steel band in the form of duplex spring leaflets in various sizes and shapes. According to green et al this matrix was considered too rigid for adequate adaptability to the tooth.¹⁴

Harris in 1889 introduced collar, or band matrices that consisted of a seamless, continuous band made of gold, platinum, copper, or German silver. Goodhugh in 1921 modified the collar matrix which was named as Harrison nickel-ferrule matrix. This matrix consisted of a nickel or German silver collar that was adapted to the tooth with pliers by pinching the collar at the facial surface. Nichols (1930) added a screw and wedge in order to improve the stability and to adapt the band closer to the cervical margin. Markley (1951) redesigned the collar, or band, matrix and introduced the

copper-band matrix. This matrix consisted of a seamless copper band, which was wedged and stabilized with a compound. To facilitate contour, the band was annealed, trimmed, and thinned in the area of the contact. It was also contoured with flat-nosed pliers. Biales, (1944) criticized the use of this matrix because of the thickness of the band, the amount of time required to fabricate the matrix, and its ineffectiveness in producing the proper contour and contact.¹⁴

Original Ivory matrix with a retainer was introduced in 1890. It was indicated for the restoration of two-surface cavities. The band extended around three-fourths of the crown of the tooth and was retained by the projections of the jaws of the retainer passing through holes in the band and engaging in the facial and lingual embrasures on the side of the tooth opposite to the cavity. Gabel et al in 1940 suggested that the matrix could be improved by wedging and burnishing for contour and contact after the matrix had been placed. He also reported that in large cavities, the band become straight from cervical to occlusal, producing a loss of contour and reducing the effectiveness of the matrix.¹⁴

Black in 1899 introduced a ligated matrix consisted of a band that extended around half the tooth and beyond all the margins of the cavity. The band was a thin plate of copper, brass, German silver, or steel with the cervical corners turned up to accommodate a ligature, when the band was placed and tied around the tooth two or three times.¹⁴

The Bonnalie, Lennox, Biber, Onderdonk, and Wagner matrices with mechanical retainers were introduced in 1930. They consisted of a circumferential

band, which could be cut on a curve and retained with a thumbscrew retainer. They were indicated for restorations of three or more surfaces. All produced loss of contact when the retainer was tightened.¹⁴

The Mizzy matrix and retainer were introduced in 1935. The matrix consisted of a band and a retainer with two metal sliding wedges which wedged the band to the contour of the tooth and held the retainer securely in place.¹⁴

The Sigveland matrix and retainer were introduced in the 1940. This matrix consisted of a circumferential band with a thumbscrew retainer and was indicated for restorations of three or more surfaces. According to Herbert & Vale the band did not contour well because it was not cut on a curve.¹⁴

Brown in 1955 reported that the Tofflemire, or Universal, matrix and retainer was designed so that the band could be easily removed from the thumbscrew retainer. The band is made of stainless steel or carbon steel, 0.0015-0.003 in (38- 76 μm) thick, and is arcuate. It can be precontoured with contouring pliers and burnished after the matrix has been placed. 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. 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.¹⁴

Reiter in 1958 introduced the All Purpose retainer which was not designed for an arcuate band, but an arcuate configuration was produced in the band through the

activation of the retainer. The band of thin, ductile stainless steel demonstrated little chance of being torn by the retaining nut upon tightening around the tooth.¹⁴

In 1973 Automatrix was introduced that consists of a coiled band, 0.0015-0.002 in (38- 51µm) thick, of various sizes and an auto-lock which secures the band. The coiled band is placed with pliers and tightened around the tooth with the Automate II instrument. According to Strickland & Wilder et al Automatrix is indicated in large posterior restorations and those with one or more cusps needing replacement. The advantages of the Auto matrix include ease of manipulation, convenience, and improved access and visibility.¹⁴

Gohil et al in 1973² evaluated proximal contacts in posterior teeth and factors influencing interproximal caries and made the following conclusions:

1. Interproximal contact is not merely a point contact but a contact area which is wider buccolingually than occlusogingivally.
2. The proximal contact areas of the maxillary posterior teeth are wider than those of the mandibular posterior teeth.
3. The dimensions of the proximal contact areas increase as age advances due to interproximal wear.
4. The average buccolingual and occlusogingival dimensions of the contact areas in the group with proximal caries are consistently greater than those without proximal caries.

5. Comparison of the incidence of caries at the firm and weak proximal contact areas shows that it is higher at weak contact areas.
6. The incidence of caries is higher in the contact areas where there is poor oral hygiene.
7. Occurrence of caries around the contact areas is greater in people having a high DMF index.
8. Size of the contact area, firmness of the contact, DMF index, and oral hygiene of the individual influence the incidence of interproximal caries.

Pillali et al in 1999¹⁵ demonstrated the clinical convenience of bitewing radiographs in the posterior region of the mouth for the diagnosis and following conclusions were made

1. Routine bitewing radiographs are useful and reliable diagnostic supplements in the posterior dental arches.
2. The radiographs provide an efficient and less expensive method of checking completed restorations and can also anticipate other complaints of the dental tissues.
3. This is a useful tool for monitoring the progress of caries lesions.
4. The bitewing radiograph is generally accepted as one of the highly efficient diagnostic aids for the posterior approximal caries lesion.

Leinfelder et al in 1999¹⁶ summarized the technical considerations of packable composites and concluded that packable composites may allow more convenient

placement in posterior sites and may offer some technique advantages over conventional composites.

M.Peumans et al in 2001¹⁰ evaluated the influence of the type resin composite and of the matrix band on quality of the proximal contact area in class II composite restorations and concluded that

1. The quality of the proximal contact area when placing class II resin composite restorations is greatly influenced by the type of matrix system used.
2. The type of resin (packable or conventional) composite did not play a significant role in obtaining strong proximal contacts when Palodent was used.
3. The operator did not have a significant influence on the tightness of the proximal contact area obtained with each technique.

Klein F et al in 2002¹⁷ evaluated whether different tooth colored materials and application techniques influence the proximal contact strengths (PCS) in vitro and concluded that PCS for the low viscosity composite was less as compared to amalgam restoration, whereas medium and high viscosity hybrid composites inserted in a multilayer technique showed no statistically significant differences to the original PCS of the unprepared teeth.

El-Badrawy et al in 2003¹⁸ assessed the quality of proximal contacts of posterior composite restorations placed with 4 restorative techniques. In this study seventy-five mounted ivorine teeth with large, standardized MOD cavities were prepared and restored with a resin composite. The restorative techniques for the 4 composite groups were traditional wedge and matrix (Group 1), use of a light-tip

attachment (Group 2), use of the Contact Pro hand instrument (Group 3) and use of Beta Quartz glass-ceramic inserts (Group 4). Three experienced clinicians independently assessed the quality of the proximal contacts of all restored teeth and concluded that the use of inserts (Group 4) resulted in a better rate of acceptable proximal contacts in posterior composite restorations than the 3 other techniques.

Dunn et al in 2004¹⁹ evaluated proximal contacts with pre-polymerized composite inserts and concluded that this technique is intended to aid the practitioner in obtaining tight, broad, proximal contacts without having to purchase special instruments or materials. This method is not time-consuming, nor technically difficult. Another benefit of this technique is that, it reduces the total amount of volumetric shrinkage of restorative material inside the cavity preparation, as the composite insert is pre-polymerized before placement.

Loomans et al in 2006²⁰ investigated clinical changes in proximal contact strength in Class II composite resin restorations using circumferential and sectional matrix system with separation rings. The proximal contact tightness was measured using a tooth pressure meter immediately before treatment and directly after finishing the restoration. They concluded that Class II posterior composite resin restorations placed with a combination of sectional matrices and separation rings resulted in a stronger proximal contact than when a circumferential matrix system was used.

Loomans et al in 2006²¹ investigated the influence of composite resin consistency and placement technique on proximal contact tightness of Class II composite resin restorations. In this study three composite resins of different

consistencies: a low-viscosity (X-Flow, Dentsply), a medium- viscosity (Clearfil AP-X, Kuraray) and a high-viscosity composite (Tetric Ceram HB, Ivoclar Vivadent) was used.

Each composite was combined with six different matrix systems and separation techniques and they concluded that:

1. The use of medium- or high-viscosity instead of a low-viscosity composite resin resulted in statistically significantly tighter proximal contacts.
2. Use of a separation ring when restoring a Class II composite resin restoration has a greater influence on the obtained proximal contact tightness compared to the influence of the consistency of the composite resin.

Cenci et al in 2006²² investigated an in vivo and in vitro class II composite restorations performed with two matrix and wedge system. In this study proximal contact tightness, surface roughness, colour matching, marginal adaptation , occlusal contacts were evaluated clinically and marginal fit , proximal contour were evaluated radiographically and they reported that the matrix systems used in this study presented similar results in clinical evaluation.

In this study, in vitro evaluation was also done to assess the microleakage in class II composite restorations and they concluded that the different matrix system had no influence on sealing ability of class II composite restorations.

Loomans et al in 2006²³ evaluated the tightness of the proximal contact when placing posterior resin composite restorations with circumferential and sectional matrix

systems in an in vitro model using a special measuring device (Tooth Pressure Meter) and concluded that the use of sectional matrices combined with separation rings resulted in tighter proximal contacts compared to when circumferential systems were used and also recommended its use when posterior resin composite restorations are placed.

Loomans et al in 2007²⁴ evaluated the effect of interdental separation of a special separation ring and a wooden wedge in class II composite resin restoration. In this study the proximal contact tightness was measured by recording the frictional forces at removal of a 0.05 mm thick metal matrix band inserted between adjacent teeth. They concluded that Special separation rings may be more useful than wooden wedges when separation is required for restorative procedures.

Loomans et al in 2007²⁵ investigated changes in proximal contact tightness up to six months after the restorative treatment using Tofflemire retainer (Produits Dentaire), Palo-dent Matrix System (Dentsply Caulk) or Contact Matrix System (Danville Materials) and reported that

1. Proximal contacts that increased in tightness as result of the treatment tend to loose tightness after a six-months period but remain tighter than before treatment.
2. Proximal contacts that decreased after treatment hardly change after six months.

Gilmour et al in 2008¹¹ compared the effectiveness of a disposable metal matrix band system and the Siqveland matrix system in the restoration of a Class II preparation with amalgam and concluded that :

1. A commonly used matrix band (Siqveland), when compared to a newer, disposable system (Omni-matrix), was found to result in consistently larger overhangs during the restoration of class II preparations with amalgam.
2. Omni-matrix is a disposable system, the potential for cross-contamination is removed and it can, therefore, be considered a suitable replacement for the non-disposable Siqveland matrix system.

Loomans et al in 2008²⁶ compared the marginal ridge fracture strength of Class II composite resin restorations placed with a straight or contoured matrix band using composite resins with different modulus of elasticity and reported that:

1. Contoured proximal surfaces resulted in significant stronger marginal ridges compared to straight surfaces.
2. Clearfil AP-X provided a higher resistance to fracture than Filtek Supreme and Clearfil Majesty Posterior and no differences were found between Filtek Supreme and Clearfil Majesty Posterior.

Kiremitci et al in 2009²⁷ evaluated the six-year clinical performance of Filtek P60 (3M ESPE) packable composite restorations in combination with a one-bottle etch and rinse adhesive, Single Bond (3M ESPE), in Class II restorations.

In this study the following characteristics were observed: marginal adaptation, anatomical form, surface texture, marginal discoloration, surface staining, post-operative sensitivity and secondary caries and they concluded that the clinical performance of the posterior composite restorations was acceptable after six years of service.

Saber et al in 2010⁶ compared in-vitro the proximal contact tightness (PCT) of Class II resin composite restorations (RCR) placed with different established and new placement techniques and made the following conclusions:

1. Sectional matrix systems combined with separation rings still provide the greatest proximal contact tightness when placing two-surface Class II resin composite restorations compared to several new available matrix systems.
2. Use of a wedge and/or hand-instrument only to obtain interdental separation is insufficient.
3. A newly introduced system, the “Walser matrix,” does not provide tight proximal contacts despite the good proximal contour it provides.

Nguyen et al in 2010²⁸ investigated influences of socio-demographic variables on the prevalence of decayed, missing, filled (DMF) and sound teeth (St) and to determine the relative risk of teeth in different dental regions for D, M, and F, of adults living in urban and rural areas in Southern Vietnam and concluded that Molars are more at risk for being decayed than premolars and anterior teeth.

Joana Cunha-Cruz et al in 2010²⁹ estimated the prevalence of tooth wear and investigated factors associated with tooth wear in patients from general practices in the

Northwest United States and concluded that moderate to severe tooth wear is a prevalent condition in the adult population.

Kampouropoulos et al in 2010³⁰ evaluated the efficiency of various types of matrices in reconstructing the proximal contact area in Class II resin composite restorations. In this study resin composite restorations were placed using the following matrices, a circumferential straight metal matrix with Tofflemire retainer, circumferential pre-contoured metal matrix system, circumferential pre-contoured transparent matrix system and sectional precontoured metal matrix system– (Palodent) and concluded that differences were noted among all the matrices evaluated and none was proven sufficient to reconstruct the proximal contact characteristics of an intact tooth.

Saber et al in 2011³¹ compared proximal contact tightness (PCT) of MOD resin composite restorations placed with different matricing protocols. In this study Sectional matrix and Walser matrix was used . They concluded that:

1. In three-surface Class II MOD resin composite restorations, tighter proximal contacts were obtained when separation rings and Sectional matrix bands were applied simultaneously for both proximal surfaces.
2. A newer matrix/separation system i.e. Walser matrix did not produce comparable tight proximal contact to the Sectional matrix system.

Wirsching et al in 2011³² investigated the influence of cavity preparation (MO/DO/MOD) and type of matrix system on proximal contact tightness of direct

posterior composite restorations. In this study Sectional matrix with separation ring and Circumferential matrix with tofflemire retainer was used. They concluded that:

1. Use of the Sectional matrix system in two-surface Class II cavities resulted in statistically significantly tighter proximal contacts than the use of the circumferential matrix system.
2. For the three-surface no statistically significant differences in contact tightness were found between the different matrix systems.
3. Location of the cavity (mesially or distally) did not show to have any statistically significant effect on the obtained proximal contact tightness.

Zhang et al in 2011³³ evaluated the dental status using DMFT for the whole dentition and the anterior, premolar and molar regions and concluded that Molars were most frequently affected by decay.

Majety et al in 2011³⁴ evaluated the cervical marginal microleakage of class II packable composite resin restorations using flowable composite and resin modified glass ionomer as intermediate layers and whether the difference in the thickness of these intermediate layers would influence the microleakage. Intermediate restorative materials advocated for this study, included auto polymerizing composites, flowable resin composites (FRC), self cured and resin modified glass ionomer cements (RMGIC). They concluded that:

1. There was no significant difference between groups in terms of leakage scores.

2. The difference in the thickness of the intermediate layers did not significantly influence the microleakage.
3. Use of 1 mm of flowable resin composite (FRC) as an intermediate layer showed overall less microleakage when compared with the other groups.

Anand et al in 2011³⁵ evaluated the effect of cavity design on the strength of direct posterior composite restorations and concluded that conservative concave cavity design provides a significantly higher strength to direct composite restorations irrespective of the restorative material used. Such a cavity design also fulfills the objectives of minimally invasive dentistry.

Chuang et al in 2011³⁶ evaluated the proximal contact on class II composite restorations constructed using various restorative approaches by a morphological analysis. In this study two circumferential matrices and one precontoured sectional matrix was used and following conclusions were made :

1. All the interproximal matrix systems presented some deficiency in either the contact tightness or contours.
2. Although the sectional matrix system enhanced contact tightness, it caused contact concavity by formation of interproximal marginal overhang.
3. The quantitative morphologic analysis helps to examine improper proximal contact and the associated problems.

Loomans et al in 2012³⁷ investigated the marginal overhang in Class II composite restorations placed with various separation rings and placement techniques.

In this study sectional matrix was used along with three ring systems i.e. Contact Matrix System (Danville Materials), Composit- Tight Gold (Garrison), and V-Ring (Triodent)

. They concluded that :

1. None of the placement techniques and separation rings could completely prevent marginal overhang.
2. The placement technique of the separation ring has a statistically significant influence on the occurrence of marginal overhang.

Gonçalves et al in 2012³⁸ compared the proximal contact of a silorane-based resin composite with a conventional methacrylate-based resin composite in class II restorations after a 6 months follow-up period and concluded that the short-term clinical performance of a silorane-based resin composite in the proximal contacts of class II restorations was similar to the well-known methacrylate-based resin composite.

Moghaddas et al in 2012³⁹ evaluated the effect of proximal contour of class II composite restorations placed with straight or contoured matrix band using composite resins with different modulus of elasticity on stress distribution by finite element method and following conclusions were made :

1. Use of sectional matrix system results in less stress in restoration compared to Tofflemire system in posterior composite restorations.
2. Stress distribution in restorations of models of second premolar and first molar are similar, but the benefit of using sectional matrix rather than Tofflemire matrix is more prominent in first molar than second premolar.

3. The mean value of the force applied affects restoration's stress.
4. Composite resins with similar modulus of elasticity generate similar stress.

Khan et al in 2013⁴⁰ compared the proximal contacts and contours in class II composite restorations in premolars achieved with automatrix band separation ring v/s automatrix band alone . They concluded that :

1. The use of separation ring along with automatrix matrix band in class II composite restorations resulted in significantly better proximal contacts than automatrix alone.
2. The separation ring does not contribute in producing additional improvement in the proximal contours.
3. The proximal contour has no relationship with the proximal contact tightness.

Teich et al in 2014⁴¹ evaluated a single standardized interproximal contact with six brands of dental floss. They suggested that the traditional method of using dental floss to evaluate proximal contact is a practical method to be used in dental practice.

Choudaha et al in 2015⁴² evaluated efficiency of various types of matrices in reconstructing proximal contact area in Class II resin composite restorations.

In this study Universal retainer Tofflemire with circumferential precontoured metal matrix, Automatrix , Saddle contoured metal matrices and Fender mate was used and they concluded that ideal contours and contacts were achieved with the help of the Automatrix. All restorations, regardless of the matrix system used, achieved acceptable interproximal contact.

Gomes et al in 2015⁴³ radiographically evaluated the proximal contours of composite restorations performed using different matrix systems an vivo study. In this study metal matrix along with wood wedge, sectional precontoured matrix along with elastic wedge and polyester strip with reflective edge was used and following conclusions were made:

1. No matrix systems were able to prevent resin over- contour in class II resin restoration.
2. The matrix system type affects the efficiency of the proximal contour, and the sectional matrix group resulted in higher incidence of correct proximal anatomical contours when compared to metal matrix and polyester matrix.
3. The location of the restoration(mesial or distal)had no statistically significant effect on whether the proximal contacts were incorrect.

Hoseinifar et al in 2017⁴⁴ evaluated the clinical performance of a packable and a low shrinkage methacrylate-based composite after one year and concluded that Kalore GC and Filtek P60 showed acceptable clinical performance after one year of service.

MATERIALS AND METHOD

MATERIALS AND METHOD

The present study was conducted in the Department of Conservative dentistry and Endodontics, with the objective to evaluate and compare interproximal contact and contour in class II composite restorations in molar teeth using Sectional contoured matrix and Saddle matrix.

Ethics committee approval:

The ethical committee approval for this clinical trial was requested and granted by the registered ethics board of college. This clinical trial was also registered with Clinical Trial Registry of India.

Study Participants:

Subjects included in the study were recruited from the regular pool of patients visiting the Department of Conservative dentistry and Endodontics. Eighty patients

requiring proximal restoration in molar teeth of any quadrant were selected for the study.

SELECTION CRITERIA :

Inclusion Criteria:

1. Molar teeth with proximal caries involving less than two third of intercuspal distance.
2. Age 18-60 years.

Exclusion Criteria:

1. Teeth with non-carious tooth surface lesions.
2. Teeth with orthodontic bands and brackets.
3. Patients whose adjacent teeth is missing.
4. Poorly restored adjacent teeth.
5. Partially erupted teeth.
6. Fractured teeth.

Treatment groups:

Group I: Teeth restored with composite resin using Sectional contoured matrix (n=40)

Group II: Teeth restored with composite resin using Saddle matrix (n = 40)

Patient consent:

Patients fulfilling the criteria were duly selected. The purpose of the study was explained to them in detail. It was further informed that, such treatments are regularly used in dental practice which does not involve any additional risks. Patients were also informed about confidentiality of data to be collected and their participation was

entirely on voluntary basis, following this informed consent was signed by them and were kept as a record.

Preoperative evaluation:

A brief case history of all the participants was recorded by a single clinician. The same clinician rendered the treatment to all patients to eliminate or minimize interpersonal variability in the treatment between clinicians.

Two blinded investigators evaluated the contact and contour of all participants before initiation of treatment. This was done using dental floss and bitewing radiograph. The data collected for each patient was recorded as per grading system mentioned below :

Clinical examination using dental floss :

Grade I : Slight resistance with fraying of floss.

Grade II : No resistance

Bitewing radiograph examination :

Grade I : Gap of less than 0.5mm

Grade II : Gap of 0.5mm to 1mm

DATA COLLECTION:

Randomization of samples was done by allocating the patients to alternate groups. Half of the subjects were assigned to group I (teeth restored with composite resin using sectional contoured matrix) and half were assigned to group II (teeth restored with composite resin using saddle matrix).

ARAMAMENTARIUM :

Instruments and Equipment:

- Straight probe (GDC, India) (PLATE I)
- Explorer (GDC, India) (PLATE I)
- Pair of Tweezers (GDC, India) (PLATE I)
- Front surface mouth mirror (GDC, India) (PLATE I)
- Excavator (GDC, India) (PLATE I)
- Enamel Hatchet (GDC, India) (PLATE I)
- Hoe (GDC, India) (PLATE I)
- Composite instruments (Hu - Friedy, Chicago) (PLATE I)
- Saddle matrix (Filaydent India) (PLATE II)
- Sectional contoured matrix (Safe plus India) (PLATE II)
- Rubber dam kit: (Hygenic Dental Dam Kit, Coltene) (PLATE I)
 - Clamp
 - Forcep
 - Sheet
 - Frame
- Cotton holder (GDC, India) (PLATE I)
- Waste receiver (GDC India) (PLATE I)
- Suction tips
- Digital radiovisiography system (Kodak 5100 RVG, France)
- LED Light curing gun (Bluephase N Ivoclar vivadent, Liechtenstein)
(PLATE III)
- Air rotar hand piece (NSK, Japan) (PLATE III)

- Rotary burs: (PLATE II)
 - Short tapered (TC – 26 ,Mani ,Japan)
 - Straight bur (SF – 41, Mani ,Japan)
 - Carbide bur(No 245 SS White India)
 - Pear shaped finishing bur (EX – 21EF Mani, Japan)
- Dental floss (Colgate, India) (PLATE I)
- Articulating paper(Dento Kem, India) (PLATE III)
- Composite polishing kit (Shofu, Japan) (PLATE III)

Materials

- Etchant (3M ESPE) (PLATE III)
- Bond (3M ESPE) (PLATE III)
- Filtek p 60 composite (3M ESPE USA) (PLATE III)
- Applicator Tip (PLATE III)

Treatment procedure:

After preoperative evaluation, minimum three teeth (one, the selected tooth for treatment and the other two adjacent teeth for assessment of contact and contour) were isolated with a rubber dam (Hygenic Dental Dam Kit, Coltene). A class II cavity was prepared with high speed airtor hand piece (NSK, Japan) using a long pear shaped no 245 (SS White Delhi, India), small straight diamond bur (SF – 41 Mani, Japan) and small tapered diamond bur (TC- 26 Mani, Japan). The cavities were then refined with Enamel hatchet (GDC, India), Gingival marginal trimmer (GDC, India) and Hoe (GDC, India). The cavity design was conservative restricted to caries removal. Teeth in group I received Sectional contoured matrix band (safe plus India). The band was secured on to the prepared tooth and burnished against the adjacent wall gently. The BiTine ring

was placed with help of retainer forcep. Teeth in group II received Saddle contoured matrix (Filaydent, India) The band and retainer together was secured on to the prepared tooth.

All the prepared teeth were etched with 37% phosphoric acid for 10 secs and then rinsed and dried. A single bond fifth generation adhesive (3M ESPE) was applied, cured and subsequently restored with filtek P60 composite using incremental method. The restoration was carved and finished with composite instruments (Hu - Friedy, Chicago). After completion of the restoration the matrix band assembly, rubber dam was removed and the occlusion was adjusted. High points were checked with help of articulating paper (Dento Kem, India) and were removed with help of finishing bur (EX – 21EF, Mani, Japan). The restoration was then polished with help of composite polishing kit (Shofu, Japan).

Post-operative Evaluation :

After completion of the restoration, postoperative evaluation was done by the same two blinded investigators, who evaluated preoperatively. Proximal contact tightness was checked with help of dental floss. Proximal contour, overhang and gap was evaluated by postoperative bitewing radiograph. Evaluation was done as per the grading system mentioned below :

Evaluation of contact tightness with dental floss:

Grade I : high resistance and does not passes at all

Grade II : resistance but passes

Grade III : no resistance

Evaluation of overhang using radiograph :

Grade I : no overhang

Grade II : overhang < 0.5mm

Grade III : overhang > 1mm

Evaluation of gap using radiograph :

Grade I : no gap

Grade II : gap of < 0.5mm

Grade III : gap of >0.5mm

ALGORITHM FOR METHODOLOGY

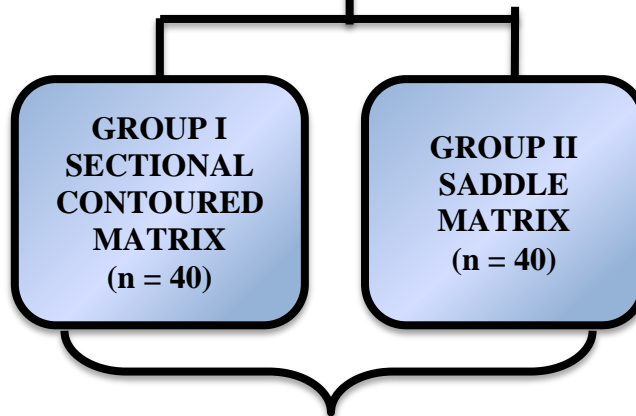
Patient requiring proximal restoration in molar teeth of any quadrant
(n=80)



Selection of case as per inclusion criteria



Allocation of teeth of a patient to treatment groups



Preoperative evaluation was done



Selected Teeth were restored with composite resin using Sectional contoured matrix and Saddle matrix



Postoperative evaluation

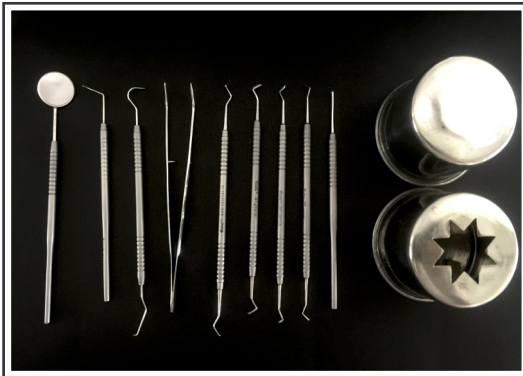


Clinical examination Radiographic examination

Results were subjected to statistical analysis

PLATE - I

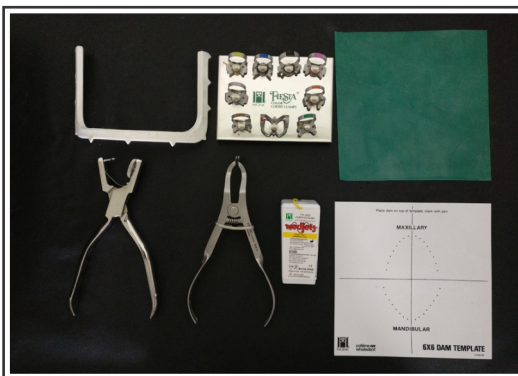
ARMAMENTARIUM



**Hand Instruments, Cotton holder,
Waster receiver**
(GDC, India)



Composite Instruments
(Hu-Friedy, Chicago)



Rubber Dam Kit
(Hygenic Dental Dam Kit, Coltene)



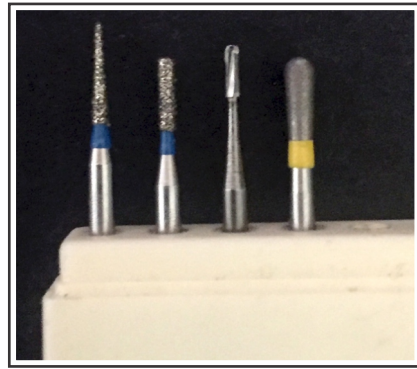
Dental Floss
(Colgate, India)

PLATE - II

ARMAMENTARIUM



High Speed Handpiece
(NSK, Japan)



Burs



Sectional Contoured Matrix System
(Safe Plus)



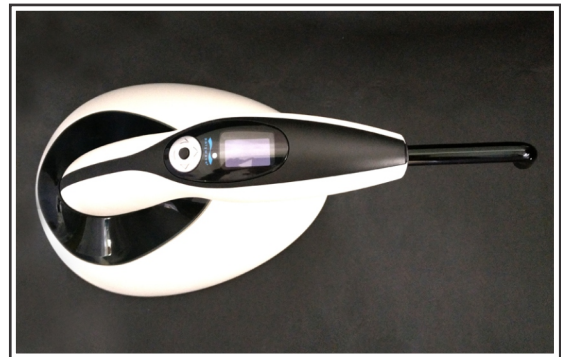
Saddle Matrix System
(Filaydent)

PLATE - III

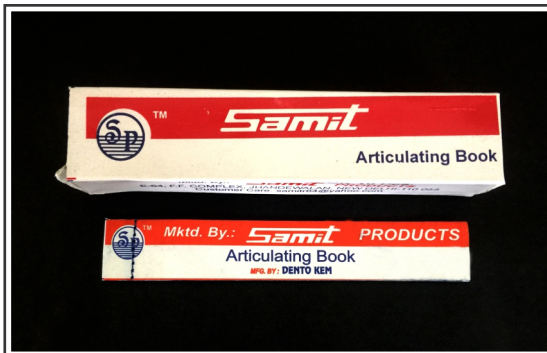
ARMAMENTARIUM



**Etchant, Bonding Agent, Applicator
Tip and Composite Resin**
(3M ESPE)



Light Curing Gun
(Bluephase N, Ivoclar Vivadent, Liechtenstein)



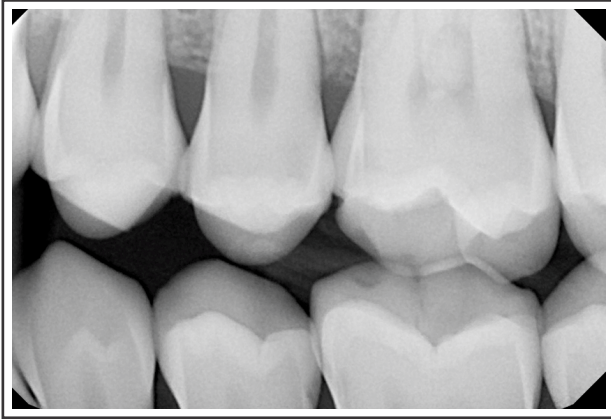
Articulating Paper
(Dento Kem, India)



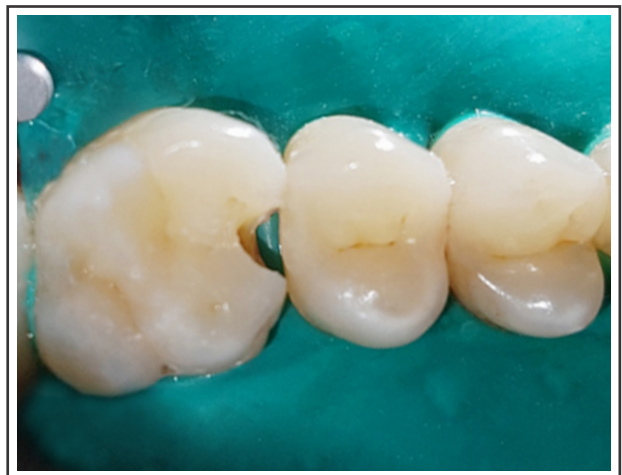
Composite Polishing Kit
(Shofu, Japan)

RESTORATIVE PROCEDURE

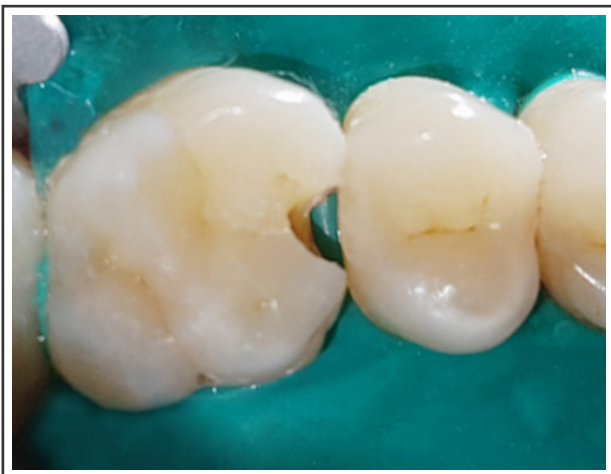
GROUP I (SECTIONAL CONTOURED MATRIX)



Preoperative Bitewing Radiograph



Isolation with Rubber Dam



Preoperative Clinical Photograph

RESTORATIVE PROCEDURE

GROUP I (SECTIONAL CONTOURED MATRIX)



**Preoperative Evaluation
with Floss**



Cavity Preparation



**Placement of Sectional
Contoured Matrix**

RESTORATIVE PROCEDURE

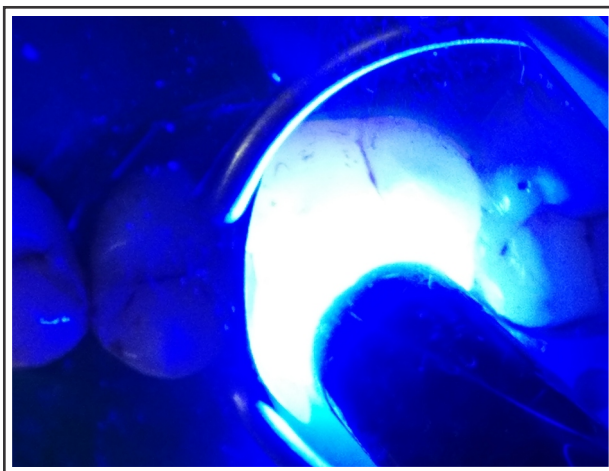
GROUP I (SECTIONAL CONTOURED MATRIX)



Etching



Application of Bonding Agent



Curing of Composite Restoration

PLATE - VII

RESTORATIVE PROCEDURE

GROUP I (SECTIONAL CONTOURED MATRIX)



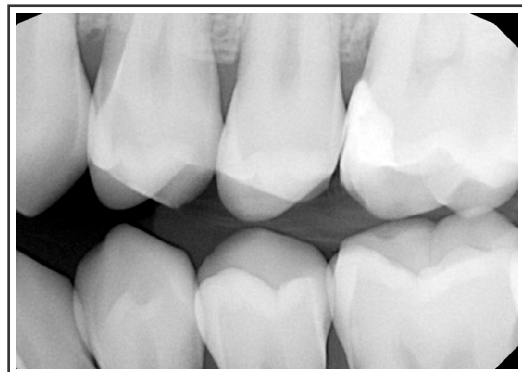
Polishing of the Restoration



Final Restoration



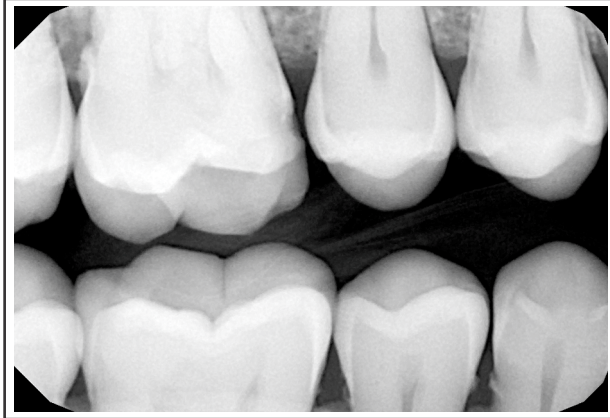
Postoperative Evaluation with Floss



Post operative Bitewing Radiograph

RESTORATIVE PROCEDURE

GROUP II (SADDLE MATRIX)



Preoperative Bitewing Radiograph



Isolation with Rubber Dam



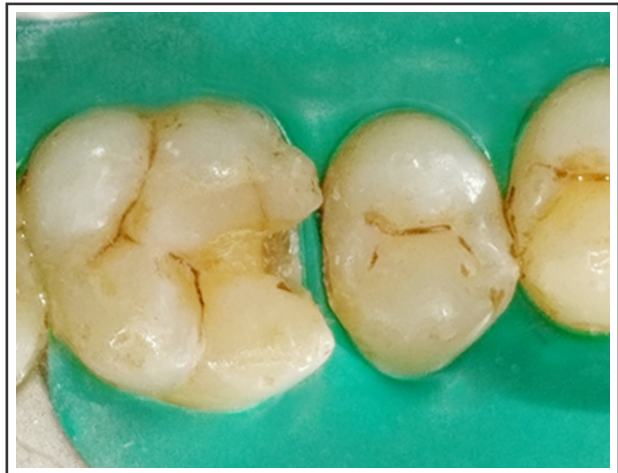
Preoperative Clinical Photograph

RESTORATIVE PROCEDURE

GROUP II (SADDLE MATRIX)



Preoperative Evaluation with Floss



Cavity Preparation



Placement of Saddle Matrix

PLATE - X

RESTORATIVE PROCEDURE

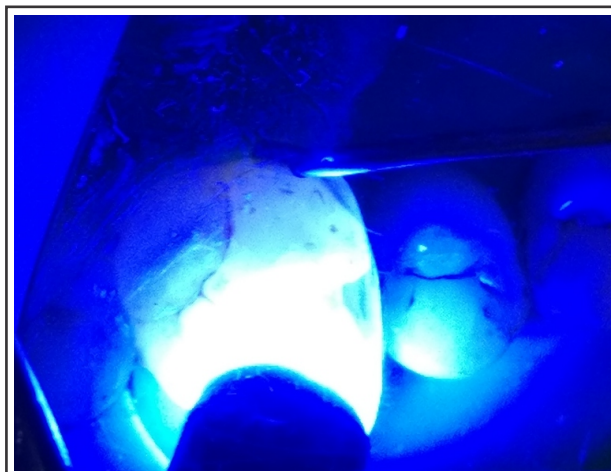
GROUP II (SADDLE MATRIX)



Etching



Application of Bonding Agent



Curing of Composite Restoration

RESTORATIVE PROCEDURE

GROUP II (SADDLE MATRIX)



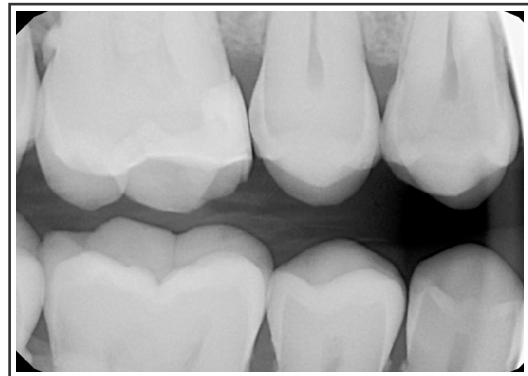
Polishing of the Restoration



Final Restoration



Postoperative Evaluation with Floss



Postoperative Bitewing Radiograph

RESULTS

RESULTS

The present in vivo study was carried out to clinically evaluate and compare the contact and contours achieved in class II composite resin restoration in molar teeth using two matrix systems. i.e. Sectional contoured matrix and Saddle matrix system through a prospective randomized trial.

Patients identified as suitable for the study were asked to give their consent to be involved.

Two treatment groups included:

Group I : Teeth restored with Sectional contoured matrix (n = 40)

Group II : Teeth restored with Saddle contoured matrix (n = 40)

SAMPLE SIZE CALCULATION:

Sample size calculation was done using one-tail hypothesis based on the z-test for independent proportions with 95% confidence level and 80% power of test.

STATISTICAL ANALYSIS:

The data on demographic characteristics like age was summarized in terms of mean and standard deviation, while gender distribution was expressed in terms of numbers and percentages. Inter-investigator agreements on flossing and bitewing radiographs were obtained using Cohen's Kappa coefficient. The post-operative grading of dental floss and bitewing radiograph between two matrix systems were compared using Pearson's Chi-square test. All the analyses were performed using SPSS ver 20.0 (IBM Corp.)

Brief description of methods is given below:

A) Sample mean for a set of observations is given

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$$

B) Standard deviation for a set of observations is given by

$$s = \sqrt{\frac{1}{(n-1)} \sum_{i=1}^n (x_i - \bar{x})^2}$$

where x_i = observation on each object

n =number of objects

C) **Median:** It is the middle value of a set of values when arranged in the increasing order of magnitude.

D) **Cohen's Kappa coefficient :**

Let the distribution of subjects according to ratings by two observers is as shown in table below:

| Investigator B | Investigator A | | Total |
|-------------------|----------------|-----------|-----------|
| | 1 | 2 | |
| 1 | A | B | $B_1=A+B$ |
| 2 | C | D | $B_2=C+D$ |
| Total | $A_1=A+C$ | $A_2=B+D$ | N |

Then, Cohen's Kappa as a measure of agreement between two investigators is given by the expression:

$$Kappa = \frac{P_o - P_e}{1 - P_e}$$

where

$$p_o = \frac{A+D}{N} \text{ and}$$

$$p_e = \left(\frac{A_1}{N}\right)\left(\frac{B_1}{N}\right) + \left(\frac{A_2}{N}\right)\left(\frac{B_2}{N}\right)$$

p_o measures the observed agreement between the two investigator, while p_e estimates the chance that both the investigators independently classify the subject into the same category.

E) Chi-square test

Let X and Y be two variables under study with r and s levels respectively; and the data on $r \times s$ levels be in the form of counts. Let the null hypothesis be that the two variables are independent. i.e. knowing the levels of X does not help in predicting the levels of Y . The alternative hypothesis that the two factors are not independent i.e, knowing the level of X can help in predicting levels of Y . To decide about the acceptance of hypothesis, the Chi-square test statistic is used which is defined as:

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^s \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where O_{ij} is the observed frequency count for i^{th} level of variable X and j^{th} level of variable Y . E_{ij} is the expected frequency count for same cell. The expected count is given by

$$E_{ij} = \frac{n_i \times n_j}{n}$$

where n_i and n_j are the total counts for i^{th} level of variable X and j^{th} level of variable Y ; and n is the total count. The calculated Chi-square value is compared with the tabulated one for $(r-1) \times (s-1)$ degree of freedom. If the corresponding p -value is smaller than the

pre-decided significance level, say 0.05, then we reject the null hypothesis and accept the alternative one. If the p-value is more than 0.05, then we accept null hypothesis.

OVERALL RESULTS

Table 1 provides the demographic profile of patients in two study groups. The mean age of patients in Saddle matrix group was 32.175 ± 6.691 years, while that of Sectional contoured matrix group was 32.475 ± 6.481 years. The gender distribution of males and females was equal (50%) in Saddle matrix group, while in Sectional contoured matrix, it was 60% males and 40% females.

Table 2 gives the distribution of patients according to parameter grades given preoperatively in sectional contoured matrix group. With respect to dental floss, there were 26 (65%) patients with grade I, and 14 (35%) with grade II. For bitewing radiograph, 28 (70.0%) had grade I, while 12 (30.0%) had grade II.

Table 3 gives the distribution of patients according to parameter grades given preoperatively in saddle matrix group. With respect to dental floss, there were 20 (50%) patients with grade I, and 20 (50%) with grade II. For bitewing radiograph, 21 (52.5%) had grade I, while 19 (47.5%) had grade II.

The distribution of patients according to dental floss and bitewing radiograph were insignificantly different in Saddle matrix and Sectional contoured groups as indicated by p values 0.1748 and 0.1082 respectively. In others words, randomization of patients in two groups was successful with respect to these two parameters.

Table 4 provides the agreement between investigators for two parameters i.e. flossing and bitewing radiograph using Cohen's Kappa coefficient. In Saddle matrix group, both the parameters had Kappa coefficient of 1.0 indicating perfect agreement between the investigators. Similarly, in the Sectional contoured matrix group, both the parameters showed perfect agreement with a coefficient of 1.0.

Table 5 provides the distribution of patients according to post-operative interproximal contact based on grades given with respect to dental floss in two matrix systems. In the Saddle matrix group, there were 9 (22.5%) patients with grade I of dental floss, 30 (75%) with grade II and 1 (2.5%) with grade III. In the Sectional contoured group, 6 (15%) had grade I of dental floss, 32 (80%) had grade II and 2 (5%) had grade III. The difference in the distribution of grading in two groups was insignificant with a p value of 0.6072 using Chi-square test.

Table 6 provides distribution of patients according to post-operative interproximal contact based on overhang, with respect to bitewing radiograph in two matrix systems. In Saddle matrix group there were 26 (65%) patients with grade I, 13 (32.5%) with grade II, and 1 (2.5%) with group III. In the Sectional contoured group, 6 (15%) had grade I, 32 (80%) had grade II. The difference in the distribution was statistically insignificant with a p value of 0.1628 using Chi-square test.

Table 7 provides distribution of patients according to post-operative interproximal contact based on gap evaluation in two matrix systems. In Saddle matrix group, 36 (90%) had grade I and 4 (10%) had grade II, while in Sectional contoured group, 37 (92.5%) had grade I and 3 (7.5%) had grade II. The difference between the two distributions was statistically insignificant with a p value of 0.6923 using Chi-square test.

DISCUSSION

DISCUSSION

One of the goals in restorative dentistry is to re-establish a tight proximal contact together with an optimal marginal adaptation without overhang.¹² Ideal proximal contact acts as a barrier against food impaction and facilitate hygienic cleaning. It also improves the longevity of proximal restorations and maintains the normal mesio-distal relationship of the teeth in the dental arch.³ Failure in reconstruction of proximal contact and contour can affect the tooth-periodontal complex negatively. Therefore restoration of teeth to natural form and function is essential for optimum maintenance of the oral complex.⁷

Increased esthetic demand has augmented the use of composites as a posterior Class II direct restorative material due to numerous advancements in material properties as well as preparation and restoration techniques.^{7,45,46} Packable composites have been

designed to reduce the complexities and technique sensitivities associated with restoration of class II cavity preparation.⁴⁷

Reconstruction of tight proximal contacts with Class II composite resin can be achieved by the means of a matrix system that gives support and form to the restorative material during its insertion and hardening.^{7,30} Various studies evaluating matrix systems have stated that obtaining an adequate proximal contact involves a correct tooth preparation, a well-adapted matrix, and an appropriate insertion and modeling of the direct restorative material.^{9,19} Traditionally used matrices are tofflemire matrix and ivory matrix system. In the past few years, newer matrix systems such as sectional contoured matrix, saddle matrix, automatrix, V3 matrix etc. have gained popularity. Researches have evaluated proximal contact tightness and contour in class II composite resin restoration using different matrix systems such as automatrix, omnimatix, V3matrix etc.^{10,11} However, a conclusive evidence regarding comparison of the contact tightness and contour achieved by sectional contoured matrix and saddle matrix is still lacking.

Thus, the purpose of this in vivo study was to evaluate and compare the contact and contours achieved in class II composite resin restoration in molar teeth using two matrix systems. i.e. Sectional contoured matrix and Saddle matrix system.

A randomized clinical trial was designed in which subjects were recruited from the regular pool of patients visiting the Department of Conservative dentistry and Endodontics. Total eighty patients requiring proximal restoration were selected in the study. Sample size was calculated on the basis of the research done by **Gomes et al in**

2015.⁴³ According to their study the proportion of restorations classified as correct with sectional contoured matrix was reported as 0.9. Considering this proportion of 0.9 for sectional matrix group from above mentioned study, and assuming that the proportion in saddle matrix group could be around 0.65, the estimated sample size based on z-test for independent proportions was minimum 34 per group. Therefore in the present study, we have considered a sample of 40 per group.

In this study, two substantially homogenous groups were selected with the inclusion criteria of having proximal caries in molar teeth of any quadrant. **Nguyen et al in 2010²⁸ and Zhang et al in 2011³³** reported that molars are more at risk for being decayed than premolars and anterior teeth. Therefore molars of any quadrant were selected for this study.

Various morphological changes occur in teeth as the age advances. In young teeth pulp horns extend from the chamber into the cuspal region. They are extensive and may be inadvertently exposed during routine cavity preparation. The pulp space becomes asymmetrically smaller after the root formation is complete because of continued slow production of dentin.⁴⁸In adult population , increased levels of tooth wear has been reported consistently. **Cunha-Cruz J et al in 2010²⁹** concluded that moderate to severe tooth wear is a prevalent condition in the adult population. This extreme age variations could affect the standard protocol used in the study. Thus, in the present study patients aged between 18 to 60 years were selected.

All patients having teeth with non-carious tooth surface lesions, fractured teeth, orthodontic bands and brackets, poorly restored adjacent tooth, partially erupted teeth and missing adjacent teeth were excluded from the study.

A standard protocol was maintained for the both groups except for the use of matrix systems. The procedure encompassed a class II restoration which involved preoperative evaluation of the tooth, isolation of the tooth with rubber dam, tooth preparation, placement of matrix system and restoration of tooth with composite resin followed by finishing and polishing of restoration. Subsequently postoperative evaluation was carried out by using floss and bitewing radiograph.

In the present study, the evaluation of proximal contact and contour was done with help of dental floss and bite wing radiograph using grades mentioned in the preoperative evaluation sheet. Tightness of interproximal contact is a critical factor for the health and longevity of the dento-alveolar complex.⁴¹ Proximal contact tightness can be measured according to the United States Public Health System criteria (USPHS) in which dental floss is used to evaluate contact tightness by recording the ease of dental floss passing interdentally.²⁵ This method was mentioned by G.V. Black, who suggested the use of waxed silk floss for this purpose. The optimal tightness of the proximal contact was defined as a “snap” as the floss passed through the contact point. The FDI World Dental Federation considers this method practical in the clinic for contact area tightness (CAT) evaluation.⁴¹

Radiography is one of the most reliable sources of information for the diagnosis of dental caries.¹⁵ The early and accurate diagnosis of a proximal caries lesion enables immediate operative therapy, thereby preventing extensive tooth loss. In order to increase the frequency of detection of proximal caries, authors have recommended that visual and clinical examination be combined with bitewing radiography. The

recommendation for a posterior bitewing examination is given because it should capture an image of the crowns of the teeth from the distal surface of the canine to the distal surface of the most posterior erupted molar without overlapping. Intraoral bitewing radiographs can be obtained by either film or digital sensors. Digital systems offer reduced patient exposure, time savings, image enhancement and ease of image storage, retrieval and transmission.⁴⁹

Pillali et al in 1999¹⁵ demonstrated the clinical convenience of bitewing radiographs in the posterior region of the mouth for the diagnosis and concluded that the bitewing radiographs provide an efficient and less expensive method of checking completed restorations.

Preoperative evaluation for both the groups were done by two blinded investigators using dental floss and bitewing radiograph to reduce the bias in parametric evaluation.

Isolation of the working field is most effectively and efficiently achieved with a well-fitting rubber dam. The rubber dam provides a dry operative field during the whole procedure and such isolation is widely considered to reduce the in-service failure of restorations and thereby extend the life expectancy of restorations.⁵⁰ Thus, the use of a rubber dam to isolate and protect the tooth is mandatory. Its main role is maintaining asepsis by preventing saliva contamination from the oral cavity, as well as reduces the bacterial aerosol during cavity preparation, protecting the soft tissues of the patient, and improving visibility for the operator.

Composite restorations have revolutionized restorative dentistry due to their conservative nature, adhesive bonding and esthetic appeal. The adhesive bonding ability evades redundant removal of tooth structure for retention, prevention, and convenience. Successful restorations can be done with minimal invasive preparations.³⁵ **Anand et al in 2011**³⁵ evaluated the effect of cavity design on the strength of direct posterior composite restorations and concluded that conservative concave cavity design provides a significantly higher strength to direct composite restorations irrespective of the different type of the composite used. Such a cavity design also fulfills the objectives of minimally invasive dentistry. Thus, in the present study cavity design was done with conservative design restricted to caries removal.

The popularity of posterior resin composites have increased with the advent and advances in adhesive and esthetic dentistry.⁵¹ However, the polymerization shrinkage seems to be the major limitation of composite resins in posterior restorations. This volumetric shrinkage ranges from 2 to 5% which may cause debonding at the tooth-composite interface and subsequently lead to postoperative sensitivity, marginal staining, recurrent caries and microleakage.⁴⁴

In order to overcome these difficulties, packable composite resins were introduced to the dental market in the late 1990s, with the incorporation of ultrafine particles of colloidal silica to control the handling characteristics such as viscosity, resistance to flow and condensability. Greater the condensation pressure used, greater is the expression of residual resin, and greater is the density of the inorganic phase. Hence, this new concept resulted in advantages like better marginal adaptation, lower

potential for incorporation of microscopic porosities, lesser polymerization shrinkage, optimal mechanical characteristics like flexural strength, modulus of elasticity and coefficient of thermal expansion and greater wear resistance.⁵²

Kiremitci et al in 2009²⁷ and **Hoseinifar et al in 2017⁴⁴** concluded Filtek P60 showed acceptable clinical performance after one year of service. Thus in present study posterior packable composite Filtek P60 was used.

Finishing and polishing of composite restorations increases both the life of the restored tooth and the clinical success in terms of improved aesthetics. These techniques results in less plaque held on the restoration and less coloring on the edges as well. This acquisition has a positive effect on the aesthetics and duration of the restoration.⁵³ Therefore, in the present study finishing and polishing of the restoration was done using composite polishing kit.

A dental restoration should restore form, function, and esthetics of a tooth involved and therefore prevent the occurrence of recurrent caries and periodontal diseases.³⁷ These requirements can be fulfilled with the help of a matrix system and a direct restorative material. In the present study Sectional contoured matrix and Saddle matrix were used.

Sectional contoured matrix was first introduced in the year 1986. This system is also called as Palodent system that employs a spring BiTine ring and sectional matrices for placement of restorations in the posterior region. The rings are placed interproximally with a rubber dam clamp forcep. The spring-action of the ring creates

separation of the teeth, facilitating inter-dental preparation space as well as formation of a positive proximal contact. Sectional matrices are available in three sizes suitable for use with all posterior restorative materials.

The advantages of the sectional matrices and rings include natural contours for better control of contact areas and embrasures, ease of placement, better visualization of the operative field, and it also provides more comfort for the practitioner and the patient. Eliminating the leverage of a conventional matrix retainer allows the practitioner to use less tension, avoiding excessive compression of tooth and easier formation of anatomical proximal contact areas.⁵⁴

Another matrix system selected for this study is Saddle contoured matrices. They are stainless steel matrices that provide optimal proximal contact and contour without difficulties. It consists of matrix band and spring clip that makes it easy to use for placement of restoration in the posterior teeth. Edges of saddle matrices are performed as cylinder-shape tubes where tines of spring clip or clamp are inserted upon matrix installation. It is available in three sizes (small, medium and large). All the matrices are available in two thicknesses i.e. 0.050 mm and 0.035 mm. There are three available shapes of saddles matrices:

- Shape 1 – standard.
- Shape 2- with adjustable central part.
- Shape 3 - with enlarged sub-gingival ledge.

Postoperative evaluation was done in similar approach as preoperative evaluation using dental floss and bitewing radiograph by two blinded investigators.

To ascertain whether there is equal distribution of the patients in both groups, the preoperative data was analyzed as given in table 3 and 4. On the basis of this result we can infer that there is homogeneous and equal distribution of samples in both the groups.

In present study molars from all quadrants were included, hence the results can be extrapolated to both maxillary and mandibular molars. Table 1 shows gender and age distribution of the samples, in which the mean age of the patients in Saddle matrix group was 32.175 ± 6.691 years, while that of Sectional contoured matrix group was 32.475 ± 6.481 years. The distribution of males and females was equal (50%) in Saddle matrix group, while in Sectional contoured matrix, it was 60% males and 40% females. This result is in accordance with United States, National Health and Nutrition Examination Survey, in which they have reported that prevalence of caries in permanent teeth (DMFT) among adults aged 20 to 34 years is 85.5%.⁵⁵

There is a strong evidence base in favor of employing matrix systems for class II composite restorations. Studies done by **M.Peumans et al in 2001**¹⁰ and **Gomes et al in 2015**⁴³ recommended the use of matrix system in class II composite restorations. The present study is distinct, as we have addressed the proximal contacts and contours as two separate variables. Studies on the proximal contact tightness address the contact and contour as a single entity.^{20, 25,32} The results of this study emphasized that the proximal contact tightness is not related with contours. In fact the contact tightness is

dependent largely on the technique utilized for the proximal restoration. In this study, 80% of the patients in the sectional contoured matrix group and 75% of patients in the saddle matrix group, that were evaluated postoperatively had grade II (i.e. good proximal contact). Similarly with respect to bitewing radiograph evaluation for gap postoperatively, 92.5% of the patients in the sectional contoured matrix group and 90% of the patients in the saddle matrix group had grade I (i.e. no gap). However on postoperative comparison of proximal contact and contour with respect to both matrix using dental floss and bitewing radiograph were found to be statistically insignificant (p value 0.6072 and 0.6923 respectively). These results shows that sectional contoured matrix and saddle contoured matrix provide good proximal contact and contour in class II composite resin restoration.

These results are in agreement with studies done by **Loomans et al in 2006**²³, **Wirsching et al in 2011**³², and **Gomes et al in 2015**⁴³ who concluded that Class II posterior composite resin restorations placed with sectional contoured matrix resulted in a stronger proximal contact and contour. **Choudaha et al in 2015**⁴² reported that saddle matrix system provide acceptable interproximal contact and contour in class II composite resin restoration.

Keogh and Bertolotti suggested that the pressure exerted with ring shaped retainer of sectional contoured matrix could facilitate the formation of a proximal contact.⁵⁶ Similarly in a study conducted by **M.Peumans et al in 2001**¹⁰, suggested that the contour of the matrix also contributes to tighter proximal contact areas. Furthermore, the good proximal contact in saddle matrix group can be attributed to the

pre-contoured bands of the matrix system, as it is believed to create more anatomically correct contact surfaces.

To explain the restorations with loose or less than optimal proximal contact (10 out of 80) with respect to both the groups, is likely due to the clinician who was unable to position the matrix systems effectively.

In addition to creating a contact area of proper size, location and configuration, it is also essential to restore the proximal surface to a proper contour. Fabricating a restoration that does not reproduce the proper contour of the teeth will lead to overhanging or under hanging restorations which affects periodontium.⁵⁷ In clinical practice, it is not uncommon to observe good proximal contact but in adequate contour in proximal restoration. In the present study, presence of overhangs were more in saddle matrix group than in sectional contoured matrix group although these results were statistically insignificant (p value 0.1628) These results are in accordance with the study done **Choudaha et al in 2015**⁴² who reported that the saddle contour matrix system presented the maximum overhang with respect to all the matrix system used.

The rationale for overhang in sectional contoured matrix group can be explained in accordance with study done by **Loomans et al in 2009**¹² who reported that the tines of the Palodent BiTine ring are parallel to each other and relatively shorter and therefore, the BiTine ring engages the tooth more occlusally, which might result in larger gaps between the preparation and matrix at the cervical area.

Likewise the probable reason for overhang in saddle matrix group was explained by **Chaung et al in 2011**³⁶ who reported that higher condensation force during placement of packable composite leads to displacement of the matrix, which may be associated with the formation of overhang.

In conclusion, we can infer that a matrix system is a crucial element in determining the proximal contact tightness and contour. Proximal contact and contour achieved in class II composite restoration using sectional contoured matrix and saddle matrix system are comparable. Marginal overhangs were present in class II composite resin restorations irrespective of the matrix system used.

Therefore, the null hypothesis which states that no difference would be present in the contact and contour achieved in class II composite resin restoration with respect to the both matrix systems was accepted.

LIMITATIONS

LIMITATIONS

1. There are devices that can objectively measure the contact strength in terms of unit of force such as tooth pressure meter , tension meter apparatus etc. However these devices are not commercially available and therefore we were compelled to assess the outcome in our study using traditional method of floss.
2. The contact strength of proximal restoration is supposed to change overtime on account of mesial movement and proximal wear. Further studies are required to evaluate the long term follow up of proximal composite restorations.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Re-establishment of proximal contact and contour is one of the challenges for the dentists while restoring a class II composite resin restoration. This challenge can be duly fulfilled with help of a matrix system. Various advances in matrix systems have been evolved in recent years. However, the effectiveness of matrix band in re-establishment of contact and contour in class II composite resin restoration still needs to be evaluated.

So the aim of the present study was to evaluate and compare the contact and contours achieved in class II composite resin restoration in molar teeth using two matrix systems. i.e. Sectional contoured matrix and Saddle matrix system through a prospective randomized trial.

Subjects included in the study were recruited from the regular pool of patients visiting the Department of Conservative dentistry and Endodontics. Total of eighty (80) patients requiring class II composite resin restoration in molar teeth of any quadrants were considered for study. Patients identified as suitable for the study were asked to give their consent to be involved.

Two treatment groups included:

- Group I : Teeth restored with Sectional contoured matrix (n = 40)
- Group II : Teeth restored with Saddle contoured matrix (n = 40)

Standard class II composite resin restoration were performed using same protocol in both treatment groups except for the use of different matrix system.

Preoperative and postoperative evaluation was done as per the grading system mentioned in evaluation sheet with help of dental floss and bitewing radiograph by two blinded investigators. The results were statistically compared and following conclusions were drawn:

1. Postoperative comparison of contact tightness with dental floss with respect to both the matrix system was found to be statistically insignificant (p value 0.6072)
2. Postoperative comparison of overhang and gap evaluation with help of bitewing radiograph with respect to both the matrix system were statistically insignificant (p value of 0.1628 and 0.6923 respectively).

Under limitations of this study we conclude that a matrix system is an essential modality to triumph a good quality proximal contact and contour in class II composite resin restoration. Sectional contoured matrix and Saddle matrix system are almost equally effective in achieving good proximal contact and contour. None of the matrix system used this study were able to prevent over contouring in class II composite restorations.

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TABLES AND GRAPHS

Table 1: Demographic characteristics of patients in two groups

| CHARACTERISTICS | SADDLE MATRIX | SECTIONAL CONTOURED MATRIX |
|-------------------------|----------------|----------------------------|
| Number | 40 | 40 |
| Age (in years) [M ± SD] | 32.175 ± 6.691 | 32.475 ± 6.481 |
| Gender [N (%)] | | |
| Male | 20 (50%) | 24 (60%) |
| Female | 20 (50%) | 16 (40%) |

Table 2: Distribution of patients according to parameter grades given preoperatively in Sectional contoured matrix group

| PARAMETER | SECTIONAL CONTOURED MATRIX (N=40) | |
|---------------------|-----------------------------------|------------|
| | Grade | No. (%) |
| Dental floss | I | 26 (65%) |
| | II | 14 (35%) |
| Bitewing radiograph | I | 28 (70.0%) |
| | II | 12 (30.0%) |

Table 3: Distribution of patients according to parameter grades given preoperatively in Saddle matrix group

| PARAMETER | SADDLE MATRIX SYSTEM (N=40) | |
|---------------------|-----------------------------|------------|
| | Grade | No. (%) |
| Dental floss | I | 20 (50%) |
| | II | 20 (50%) |
| Bitewing radiograph | I | 21 (52.5%) |
| | II | 19 (47.5%) |

Table 4: Inter-investigator agreement for different post-treatment parameters

| TECHNIQUE | PARAMETER | KAPPA COEFFICIENT |
|----------------------------|---------------------|-------------------|
| Saddle matrix | Flossing | 1.0 |
| | Bitewing radiograph | 1.0 |
| Sectional contoured matrix | Flossing | 1.0 |
| | Bitewing radiograph | 1.0 |

Table 5: Distribution of patients according to post-operative interproximal contact based on grades given with respect to dental floss in two matrix systems

| PARAMETER | GRADE | MATRIX SYSTEM [NO. (%) | | P-value |
|--------------|-------|------------------------|----------------------------|---------|
| | | Saddle (n=40) | Sectional contoured (n=40) | |
| Dental floss | | | | |
| | I | 9 (22.5%) | 6 (15%) | 0.6072 |
| | II | 30 (75%) | 32 (80%) | |
| | III | 1 (2.5%) | 2 (5%) | |

Table 6: Distribution of patients according to post-operative interproximal contact based on overhang, with respect to bitewing radiograph in two matrix systems

| PARAMETER | GRADE | MATRIX SYSTEM [NO. (%) | | P-value |
|-----------|-------|------------------------|----------------------------|---------|
| | | Saddle (n=40) | Sectional contoured (n=40) | |
| Overhang | | | | |
| | I | 26 (65%) | 33 (82.5%) | 0.1628 |
| | II | 13 (32.5%) | 7 (17.5%) | |
| | III | 1 (2.5%) | 0 | |

Table 7: Distribution of patients according to post-operative interproximal contact based on gap evaluation in two matrix systems

| PARAMETER | GRADE | MATRIX SYSTEM [NO. (%) | | |
|----------------|-------|------------------------|-------------------------------|---------|
| | | Saddle (n=40) | Sectional contoured (n=40) | P-value |
| Gap evaluation | | | | |
| | I | 36 (90%) | 37 (92.5%) | 0.6923 |
| | II | 4 (10%) | 3 (7.5%) | |

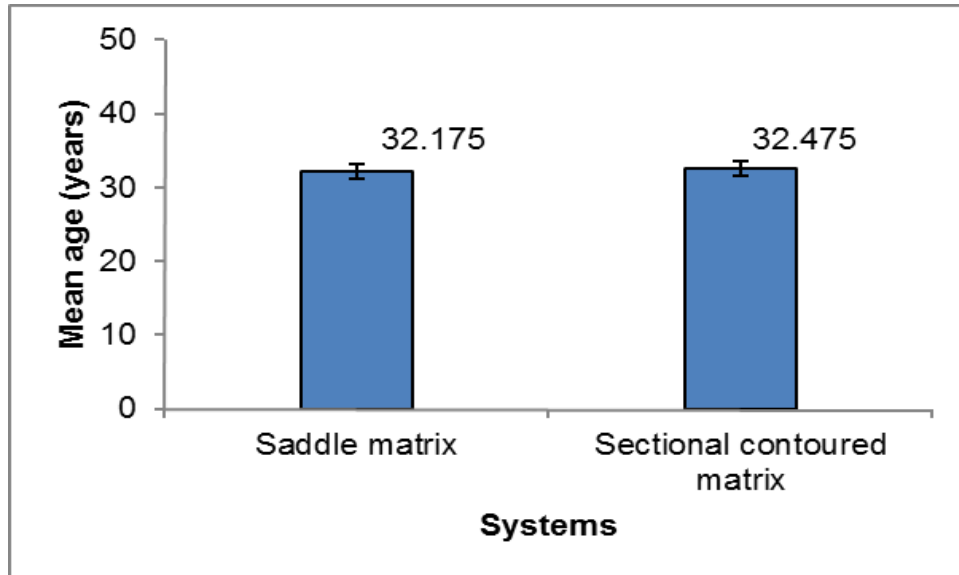


Figure 1: Column chart showing the mean age of patients in two groups

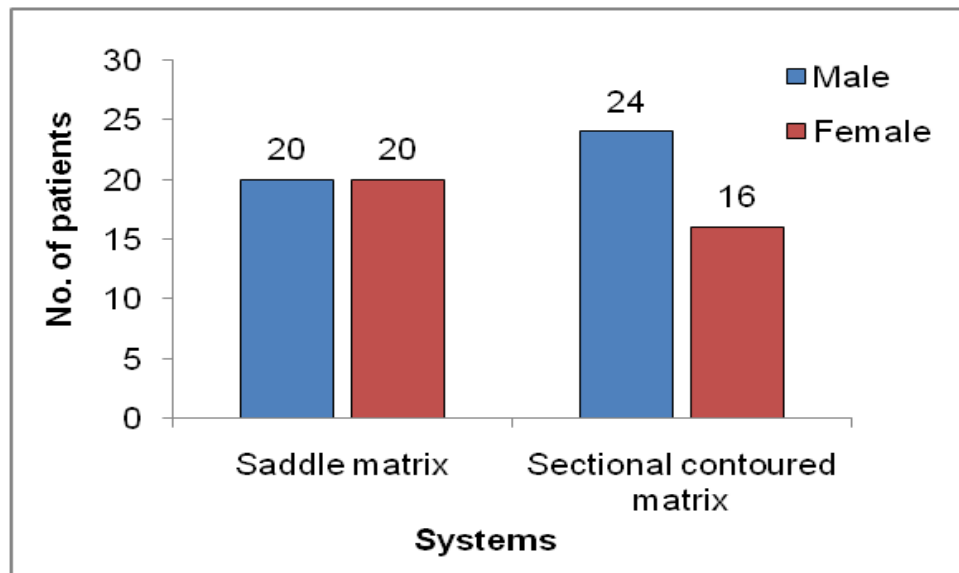


Figure 2: Column chart showing distribution of patients as per gender in two groups

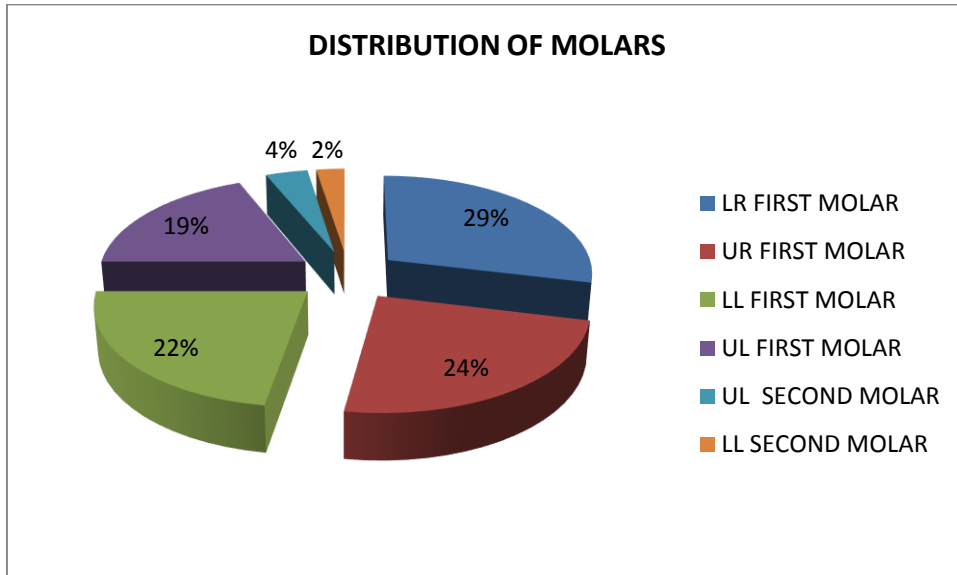


Figure 3: Pie chart showing distribution of molars in the study

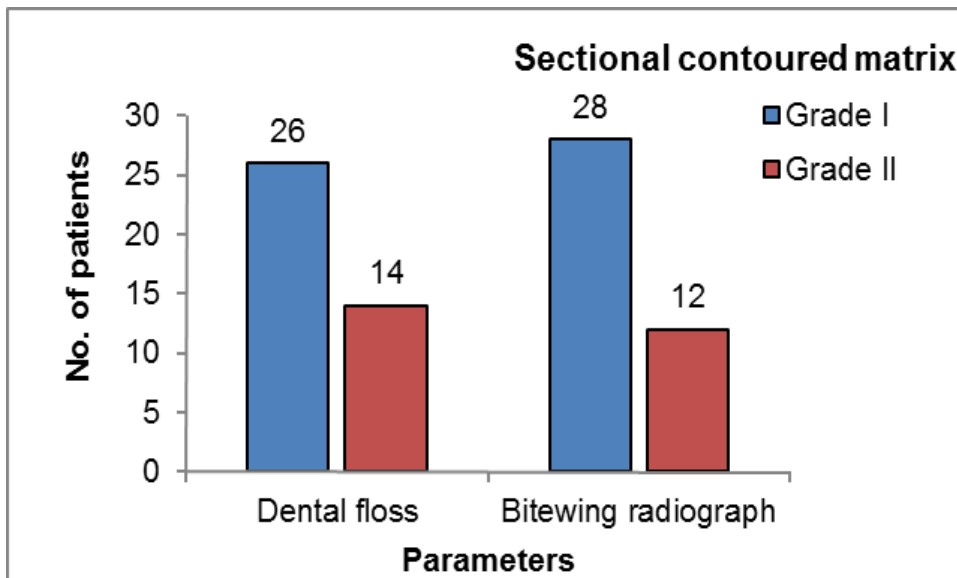


Figure 4: Column chart showing number of patients according to parameter grades given preoperatively in Sectional contoured matrix group

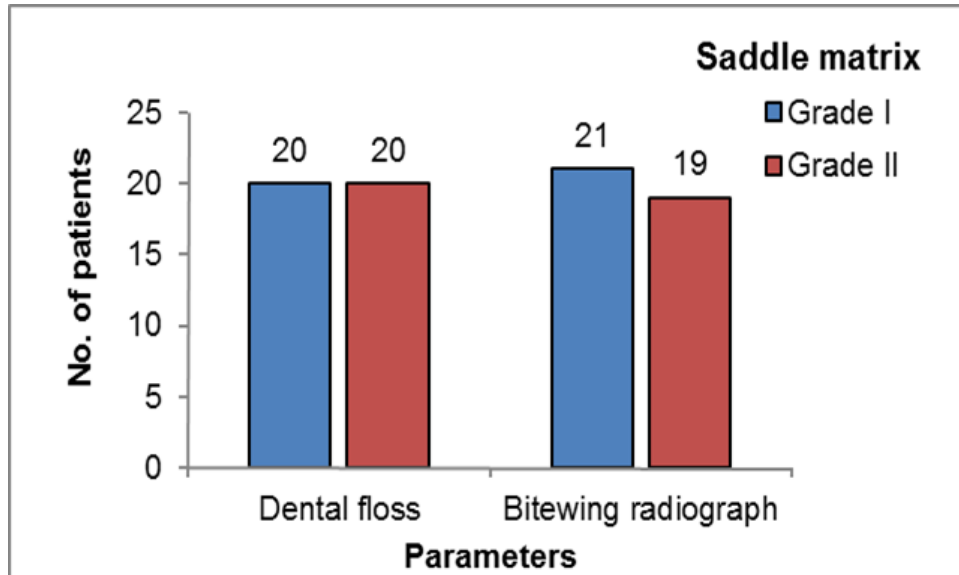


Figure 5: Column chart showing number of patients according to parameter grades given preoperatively in Saddle matrix group

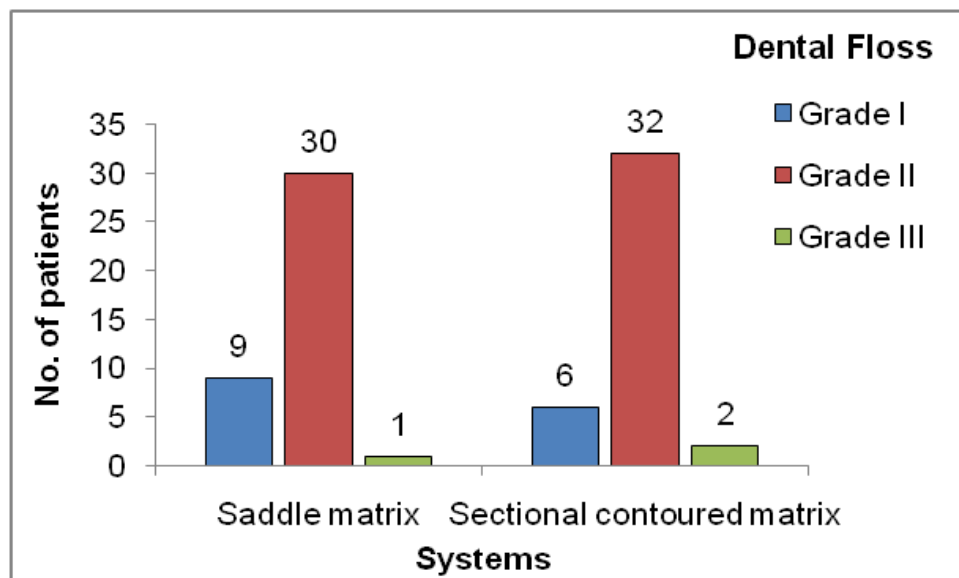


Figure 6: Column chart showing post-operative number of patients in each group as per grades given with respect to dental floss

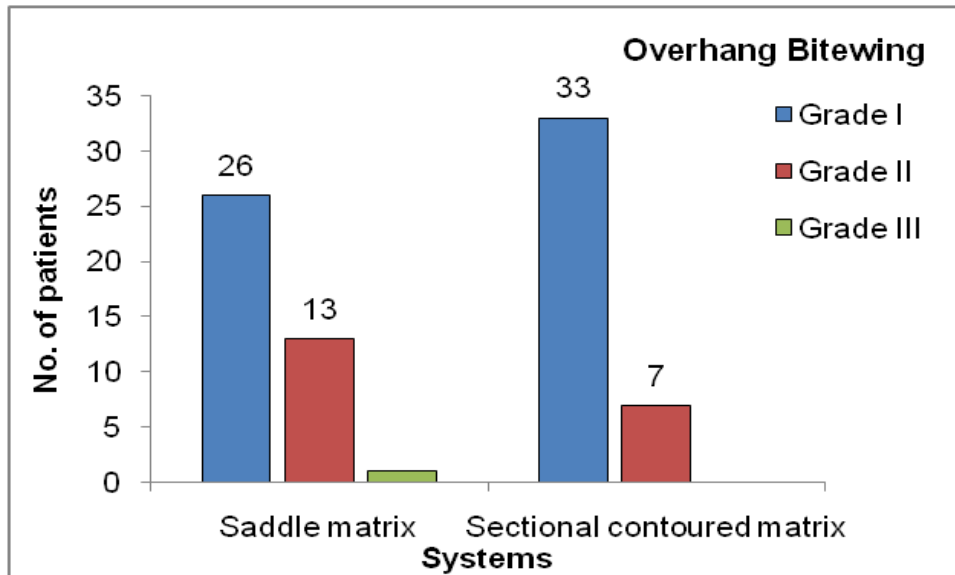


Figure 7: Column chart showing post-operative number of patients in each group as per grade given for overhang, with respect to bitewing radiograph.

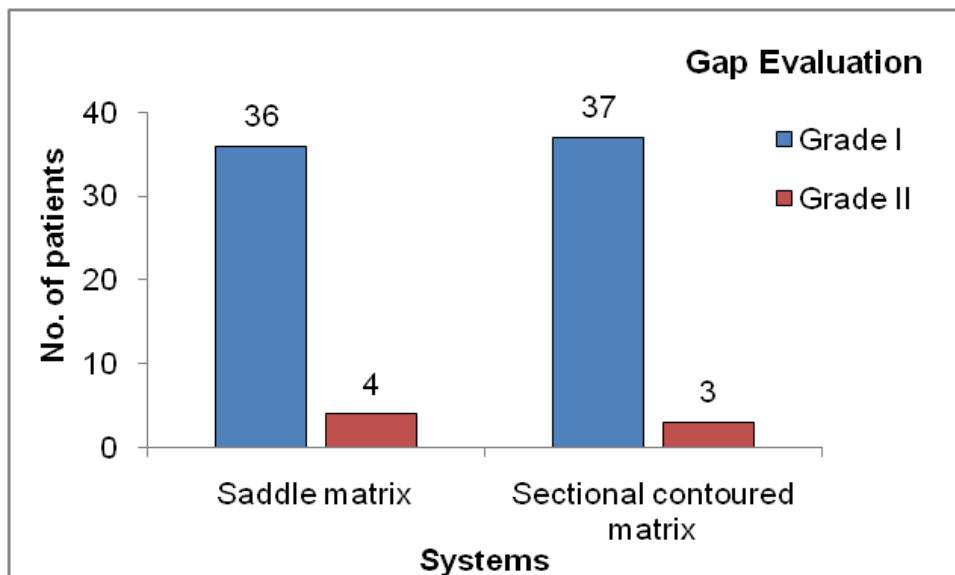


Figure 8: Column chart showing post-operative number of patients in each group as per grade given for gap evaluation, with respect to bitewing radiograph.

ANNEXURE

(Confidential)

Informed Consent Form

COMPARATIVE EVALUATION OF CONTACT AND CONTOURS IN CLASS II COMPOSITE RESIN RESTORATION IN MOLAR TEETH USING TWO MATRIX SYSTEMS: A RANDOMIZED CLINICAL TRIAL

I, Mr./Master/Mrs./Miss. _____

Resident of: _____

_____ aged _____ years, exercising my free will/choice, without any pressure/lure of incentive in any form, hereby give my consent/consent for the research project.

I acknowledge that doctor has informed me about this research project suitably and sufficiently to my satisfaction. I agree to let my X-rays, photographs, impressions and other investigations to be taken as required. I agree to take part in this project and will not mix any other projects during the period of this trial. I shall report to the dental hospital or other place where called on given appointment dates and time. I shall inform the doctor on any adverse effects or unusual symptoms noticed by me. I shall co-operate with the doctors and paramedical staff, in all respects. I permit to publishing the results of my participation in this study. I shall not be given any reimbursement or compensation. I have been informed of my right to opt out of this research project at any time without giving any reason for doing so.

I hereby record my consent for participation in the said trial.

1. _____
Patient name Signature/ thumbprint Date Time

2. _____
Witness name Signature Date Time

3. _____
Investigator name Signature Date Time

PRE-OPERATIVE EVALUATION SHEET

PATIENTS NAME :

AGE/ SEX :

TOOTH INVOLVED :

Evaluator 1 ○

Evaluator 2 ○

Table 1 – Clinical examination with floss

| GRADE | CONTACT WITH FLOSS | Evaluator |
|--------------|--------------------------------------------|------------------|
| Grade I | Slight Resistance With fraying of floss | |
| Grade II | No resistance | |

Table 2 – Bitewing Radiographic examination

| GRADE | BITEWING | Evaluator |
|--------------|------------------------|------------------|
| Grade I | Gap of less than 0.5mm | |
| Grade II | Gap of 0.5mm-1mm | |

Date:

Evaluator ' s Sign:

POST- OPERATIVE EVALUATION SHEET
PATIENTS NAME :

AGE/ SEX :

TOOTH INVOLVED :

Evaluator 1 ○

Evaluator 2 ○

Table 1 – Evaluation of contact tightness with dental floss

| GRADE | CONTACT WITH FLOSS | REMARK | Evaluator |
|--------------|--------------------------------------------|----------------|------------------|
| Grade I | High Resistance and does not passes at all | Acceptable | |
| Grade II | Resistance But Passes | Good | |
| Grade III | No Resistance | Not acceptable | |

Table 2 – Evaluation of overhang using radiograph

| GRADE | BITEWING RADIOGRAPH | REMARK | Evaluator |
|--------------|----------------------------|----------------|------------------|
| Grade I | No Overhang | Good | |
| Grade II | < 0.5mm | Acceptable | |
| Grade III | > 1 mm | Not acceptable | |

Table 3 –Evaluation of gap using radiograph

| GRADE | BITEWING RADIOGRAPH | REMARK | Evaluator |
|--------------|----------------------------|----------------|------------------|
| Grade I | No gap | Good | |
| Grade II | Gap of <0.5mm | Acceptable | |
| Grade III | >0.5mm | Not acceptable | |

Date:

Evaluator ' s Sign:

MASTER CHART
Descriptive data

| SR NO | AGE /GENDER | SR NO | AGE/GENDER |
|--------------|--------------------|--------------|-------------------|
| 1 | 28/M | 41 | 28/F |
| 2 | 35/F | 42 | 40/M |
| 3 | 25/M | 43 | 26/F |
| 4 | 36/M | 44 | 25/F |
| 5 | 22/F | 45 | 30/M |
| 6 | 26/F | 46 | 32/M |
| 7 | 25/F | 47 | 38/M |
| 8 | 27/F | 48 | 26/F |
| 9 | 30/F | 49 | 41/M |
| 10 | 40/M | 50 | 42/F |
| 11 | 28/M | 51 | 45/F |
| 12 | 33/M | 52 | 40/M |
| 13 | 32/M | 53 | 42/M |
| 14 | 32/F | 54 | 28/M |
| 15 | 35/M | 55 | 29/M |
| 16 | 40/M | 56 | 35/M |
| 17 | 41/M | 57 | 26/F |
| 18 | 28/M | 58 | 42/M |
| 19 | 26/F | 59 | 34/M |
| 20 | 42/M | 60 | 28/M |
| 21 | 32/F | 61 | 25/M |
| 22 | 40/M | 62 | 22/F |
| 23 | 32/M | 63 | 31/F |
| 24 | 25/F | 64 | 28/M |
| 25 | 22/F | 65 | 32/M |
| 26 | 24/F | 66 | 40/F |
| 27 | 40/F | 67 | 44/M |
| 28 | 45/M | 68 | 36/M |
| 29 | 25/F | 69 | 29/M |
| 30 | 38/M | 70 | 30/M |
| 31 | 22/M | 71 | 26/M |
| 32 | 33/M | 72 | 35/F |
| 33 | 29/F | 73 | 36/M |
| 34 | 45/F | 74 | 30/F |
| 35 | 24/F | 75 | 33/F |
| 36 | 35/M | 76 | 25/M |
| 37 | 38/M | 77 | 22/M |
| 38 | 32/F | 78 | 28/F |
| 39 | 35/F | 79 | 40/F |
| 40 | 40/F | 80 | 30/F |

GRADING OF SECTIONAL CONTOURED MATRIX GROUP

| SR.NO | PRE FLOSS GRADE | PRE BITEWING GRADE | POST FLOSS GRADE | POST BITEWING GRADE | POST GAP GRADE |
|-------|--------------------|--------------------------|---------------------|---------------------------|-------------------|
| 1 | 1 | 1 | 2 | 1 | 1 |
| 2 | 1 | 1 | 2 | 1 | 2 |
| 3 | 1 | 1 | 2 | 1 | 1 |
| 4 | 1 | 1 | 2 | 1 | 1 |
| 5 | 1 | 1 | 1 | 1 | 1 |
| 6 | 2 | 1 | 1 | 1 | 1 |
| 7 | 1 | 1 | 2 | 1 | 1 |
| 8 | 2 | 2 | 2 | 1 | 1 |
| 9 | 1 | 1 | 2 | 1 | 1 |
| 10 | 1 | 1 | 2 | 1 | 1 |
| 11 | 1 | 1 | 2 | 2 | 1 |
| 12 | 1 | 1 | 1 | 1 | 1 |
| 13 | 1 | 1 | 2 | 1 | 1 |
| 14 | 2 | 1 | 2 | 2 | 1 |
| 15 | 1 | 1 | 1 | 2 | 1 |
| 16 | 2 | 2 | 3 | 1 | 1 |
| 17 | 1 | 1 | 2 | 1 | 1 |
| 18 | 1 | 1 | 2 | 1 | 1 |
| 19 | 1 | 1 | 2 | 1 | 1 |
| 20 | 2 | 2 | 2 | 1 | 1 |
| 21 | 1 | 2 | 2 | 1 | 2 |
| 22 | 1 | 1 | 2 | 1 | 1 |
| 23 | 1 | 1 | 2 | 1 | 1 |
| 24 | 2 | 2 | 3 | 1 | 1 |
| 25 | 2 | 2 | 1 | 1 | 1 |
| 26 | 2 | 1 | 2 | 1 | 1 |
| 27 | 1 | 1 | 2 | 2 | 2 |
| 28 | 2 | 2 | 2 | 1 | 1 |
| 29 | 2 | 2 | 2 | 2 | 1 |
| 30 | 1 | 1 | 2 | 1 | 1 |
| 31 | 2 | 2 | 2 | 1 | 1 |
| 32 | 1 | 1 | 2 | 1 | 1 |
| 33 | 1 | 1 | 1 | 1 | 1 |
| 34 | 1 | 1 | 2 | 1 | 1 |
| 35 | 2 | 2 | 2 | 1 | 1 |
| 36 | 1 | 1 | 2 | 2 | 1 |
| 37 | 1 | 1 | 2 | 2 | 1 |
| 38 | 2 | 2 | 2 | 1 | 1 |
| 39 | 2 | 2 | 2 | 1 | 1 |
| 40 | 1 | 1 | 2 | 1 | 1 |

GRADING OF SADDLE MATRIX GROUP

| SR.NO | PRE FLOSS GRADE | PRE BITEWING GRADE | POST FLOSS GRADE | POST BITEWING GRADE | POST GAP GRADE |
|-------|-----------------|--------------------|------------------|---------------------|----------------|
| 1 | 1 | 1 | 2 | 2 | 1 |
| 2 | 1 | 1 | 2 | 1 | 1 |
| 3 | 1 | 1 | 1 | 1 | 1 |
| 4 | 1 | 1 | 2 | 2 | 1 |
| 5 | 2 | 2 | 2 | 1 | 1 |
| 6 | 1 | 1 | 1 | 1 | 1 |
| 7 | 1 | 1 | 1 | 1 | 1 |
| 8 | 1 | 1 | 2 | 1 | 1 |
| 9 | 1 | 1 | 2 | 3 | 1 |
| 10 | 2 | 2 | 2 | 1 | 1 |
| 11 | 2 | 2 | 3 | 2 | 1 |
| 12 | 2 | 1 | 2 | 2 | 1 |
| 13 | 2 | 2 | 2 | 1 | 1 |
| 14 | 1 | 1 | 1 | 2 | 1 |
| 15 | 2 | 2 | 2 | 1 | 1 |
| 16 | 2 | 1 | 1 | 1 | 1 |
| 17 | 2 | 2 | 2 | 1 | 1 |
| 18 | 2 | 2 | 2 | 1 | 1 |
| 19 | 1 | 2 | 2 | 1 | 1 |
| 20 | 1 | 1 | 2 | 2 | 1 |
| 21 | 1 | 1 | 2 | 2 | 1 |
| 22 | 2 | 2 | 2 | 1 | 1 |
| 23 | 2 | 2 | 2 | 2 | 1 |
| 24 | 2 | 2 | 2 | 2 | 1 |
| 25 | 2 | 2 | 2 | 1 | 1 |
| 26 | 2 | 2 | 2 | 1 | 1 |
| 27 | 2 | 2 | 2 | 1 | 1 |
| 28 | 2 | 2 | 2 | 1 | 2 |
| 29 | 1 | 1 | 2 | 1 | 1 |
| 30 | 1 | 1 | 2 | 1 | 1 |
| 31 | 1 | 1 | 2 | 2 | 1 |
| 32 | 1 | 1 | 1 | 2 | 1 |
| 33 | 1 | 1 | 1 | 2 | 1 |
| 34 | 2 | 2 | 2 | 1 | 2 |
| 35 | 2 | 2 | 2 | 1 | 1 |
| 36 | 1 | 1 | 1 | 1 | 1 |
| 37 | 2 | 2 | 2 | 1 | 2 |
| 38 | 1 | 1 | 2 | 2 | 1 |
| 39 | 2 | 2 | 2 | 1 | 2 |
| 40 | 1 | 1 | 1 | 1 | 1 |