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Richmond crown-Recreating the historical dental art

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Abstract

Endodontically treated teeth with the loss of coronal tooth structure when left untreated for a long period may cause super-eruption, drifting, tipping, and rotation of adjacent and opposing teeth. This may be challenging to the clinician when fabricating a crown because of inadequate interocclusal space. Tooth with less remaining crown height is indicated for post and core followed by crown to restore normal anatomy, function and esthetics. Patients with reduced interocclusal clearance and having very steep incisal guidance are most difficult to manage. Richmond crown is a feasible approach for such cases that can be performed with very less incisal clearance to accommodate post, core and crown thickness. This article describes two cases of upper incisors with reduced interocclusal space treated with Richmond crowns.

Keywords: Richmond Crown, Historical dental art, Decreased interocclusal space.

Introduction

To restore badly damaged endodontically treated teeth is a common problem faced by many restorative dentists. The broken teeth often require extra support from the root canal for the additional retention of the restoration. In cases where the remaining crown structure is not sufficient to retain full-coverage crown, post and core is a treatment option to increase the retention and resistance form of tooth. The major concern with the post and core procedure is fracture of post or root, dislodgement of post–core assembly, loss of the restorative seal, and injury to the periodontium.[1] The situation may be further worsening in patient with a deep bite & markedly reduced overjet which leads to maximum oblique forces. In these situations, a one-piece cast dowel-core-crown restoration called the Richmond crown is indicated. Since it is a one-piece cast dowel-core-crown it eliminates the need for additional space required for a crown thus proving to be a boon in cases with deep bite and reduced overjet in which interocclusal space is compromised.

The Glossary of Prosthodontic terms defines Richmond Crown as an eponym for a post-retained crown made for an endodontically treated tooth that uses a porcelain facing. It was named after C.M. Richmond, an American Dentist. The Richmond crown was introduced in 1878 and incorporated a threaded tube in the canal with a screw retained crown. It was later modified to eliminate the threaded tube and was redesigned as a one-piece dowel and crown. Richmond crown is not post and core system but it is customized, castable post and crown system as both are single unit and cast together. It is easier to make cast metal restorations with the aid of posts for retention and lasting service. However, whenever possible the metal can be camouflaged by veneering with tooth-colored restorations to create a functionally as well as esthetically acceptable outcome.[2]

A ferrule effect is defined as a ‘‘360-degree metal collar of the crown surrounding the parallel walls of the dentine extending coronal to the shoulder of the preparation. The result is an elevation in resistance form of the crown from the extension of dentinal tooth structure’’. More precisely, parallel walls of dentin extending coronally from the crown margin provide a ‘‘ferrule,’’ which after being encircled by a crown provides a protective effect by reducing stresses within a tooth called the ‘‘ferrule effect’.[3]

A dental ferrule has three components:[4]

1. Vertical component (Ferrule height) - around 1.5 to 2.5 mm.
2. Dentin thickness /Girth (Width of ferrule) - 1-2 mm. (Figure 1)
3. Total occlusal convergence/ Net Taper-Total draw of 2 opposing axial walls to receive a fixed crown which is 10° in 3mm of vertical ferrule, 20° in 4mm.

Figure 1: Coronal Section of a tooth showing ferrule thickness.

Generally, the ferrule effect is considered necessary to stabilize restored tooth structure. It has been proposed that the use of a ferrule as part of the core or artificial crown may be of benefit in reinforcing root-filled teeth. A protective, or ‘ferrule effect’ could occur owing to the ferrule resisting stresses such as functional lever forces, the wedging effect of tapered posts and the lateral forces exerted during the post insertion. According to various studies 1.5 mm should be the minimum ferrule length

when restoring a root-filled maxillary central incisor with a post- and core-retained crown.[2,3]

This case report describes two cases of maxillary incisors with reduced interocclusal space treated with the Richmond crown with a simple and minimally invasive technique.

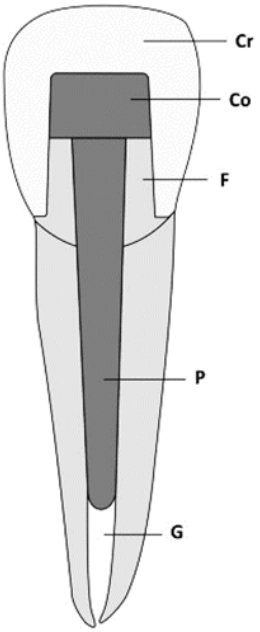


Figure 2: A schematic drawing of endodontically treated tooth restored with post and core system and a crown. Co-core, Cr-crown, F-dentin extending coronal from crown margin providing a ferrule. G- remaining gutta-percha. P- post.[3]

Case report-1

A 54 years old female patient reported to the department of Conservative Dentistry and Endodontics at at Haldia Institute of Dental Sciences & Research with the chief complaints of sensitivity & pain while taking hot beverages in her upper front teeth region of jaw. On clinical examination erosion was observed on maxillary anterior teeth which was strongly noticeable in the maxillary left central & lateral incisor (Figure 1B). The teeth were not tender in vertical percussion with delayed response to electric pulp test & had a decreased overjet (Figure 3C). Radiographic examination revealed no such abnormality at the periapical region of these teeth (Figure 3B). Clinically diagnosis of symptomatic irreversible pulpitis was established irt 21 & 22.

As it was found that there was decreased overjet (Figure 3C) to restore the tooth to normal function and esthetics, so it was planned to give a Richmond crown irt 21& 22 to the patient after completion of endodontic treatment. The entire treatment plan was explained to the patient.

Under local anesthesia, root canal therapy was initiated under rubber dam isolation using split dam technique. In first appointment, the shade selection were finalized first (B2, Vita classical shade guide, Germany) and access cavity was prepared by achieving a bur drop with a no.2 round bur (SS White, USA) after which, the roof of the chamber was removed completely with the help of an Endo Z bur (Dentsply Maillefer, Switzerland). The orifice was explored with the help of an Endo explorer (Dentsply Maillefer, Switzerland) probe. Initial negotiation into these canals was done using No. 15 hand K file (Mani, Japan). The initial apical file was found to a size of 20 hand k File (Mani, Japan) of which working length was determined with an apex locator (Canal pro, Coltene, Switzerland) and confirmed radiographically. The master apical preparation was made till 50 K Files (Mani, Japan) followed by the remaining part root canal was enlarged up to 70 k hand files using step back technique. Lastly a size 40 H file was used in circumferential motion to smoothen the canal. 17% EDTA gel was used as a lubricant during shaping and 5.25% sodium hypochlorite and 17% EDTA liquid were used as an irrigant. In second appointment, obturation was carried out with cold lateral compaction technique and using Sealapex as a sealer (Kerr, USA) (Figure 3D). The patient was clinically asymptomatic throughout the Root canal treatment procedure.

After doing the standard root canal treatment the following procedure was performed.

Post space preparation-(Figure 3E)

Post space was prepared with Peeso reamer (Mani Inc., Tochigi, Japan) to remove coronal obturating material (care was taken not to disturb apical seal). The preparation part was ended with the use of H-file (Mani Inc., Tochigi, Japan) (circumferentially) to smoothen the walls, maintaining the divergence towards coronal root canal and to eliminate the undercuts into the post space.

Crown structure preparation

Firstly, remaining crown structure was prepared circumferentially for metal ceramic crown with Chamfer finish line given by TR 13 bur (Mani Inc., Tochigi, Japan).

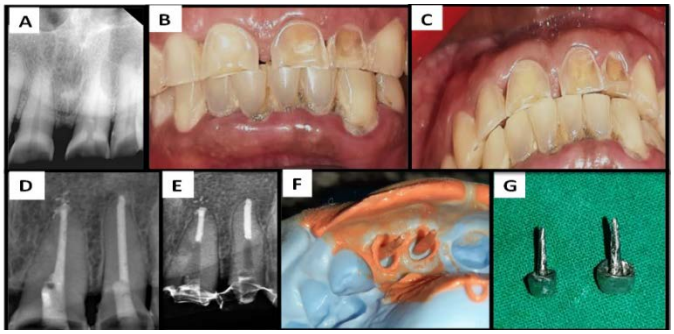
Post and core fabrication (Indirect method)

Canal was coated with light body impression material (Dentsply, Milford, USA) and then a small piece of serrated metal pin, coated with light body was placed in the canal. Later light body was injected around the prepared tooth, Heavy body putty impression material (Dentsply, Milford, USA) was loaded in stock tray and final impression is made (Figure 3F) and It was then poured with die stone and cast was obtained. The wax pattern was made and checked on the cast for proper fitting.

Crown fabrication

After prepared post and core pattern was casted in base metal alloy, A try in (Figure 3G & H). was done in the patient's mouth for proper fitting into margins. A radiograph was taken to check the proper seating of the post and core & finally ceramic layering was done (Shade B2) over the core (Figure 3I). After checking for adequate margin adaption and aesthetics, the Richmond crown was cemented with glass ionomer cement (Figure 3J,3K,3L) (GC Corporation, Tokyo, Japan).

Clinical & Radiographical follow-up was taken at the end of 6months. The teeth remain normal in esthetics & function after 6 months of follow-up. (Figure 3M,3N).



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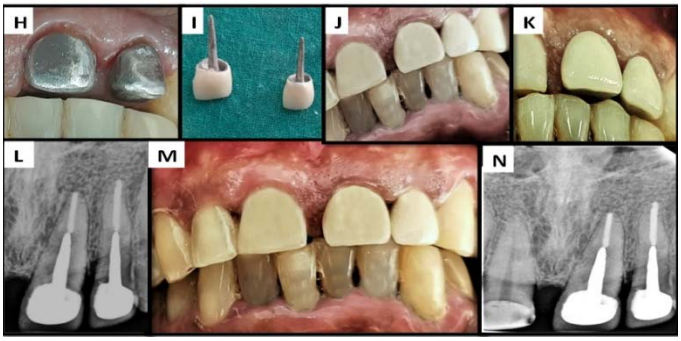


(B)

Figure 3-A: Pre-Operative radiograph & Clinical picture. C) Clinical picture showing decreased interocclusal spaces due to proclination of lower anteriors at maximum intercuspation. D) Radiograph after Obturation irt 21, 22. E) Radiograph after post space preparation irt 21 & 22. F) Indirect impression irt 21 & 22. G).

Figure 3-B: Metal casting irt 21 & 22. H) Try-in of metal casting irt 21 & 22. I) Ceramization over the metal core irt 21& 22. J) Clinical picture after Richmond crowns cementation. K) Clinical picture showing interincisal clearance at maximum intercuspation irt 21 & 22. L) Post cementation radiograph irt 21 & 22. M & N) Clinical & Radiographical follow-up after 6 months.

Case report-2

A 15-year-old male patient reported to the Department of Conservative Dentistry and Endodontics at Haldia

Institute of Dental Sciences & Research with a chief complaint of pain in his upper left front teeth region. On taking detailed history, it was revealed that the patient underwent trauma 1 year back and his maxillary left central incisor got fractured. Clinical examination showed that the tooth was tender in vertical percussion with no response response to electric pulp test. There was no discoloration of the fractured right central incisor & the tooth had an increased overbite and a decreased overjet due to the labial tipping of mandibular right lower incisor (Figure 4B,4C). Radiographic examination revealed periapical radiolucency around 21. (Figure 4A)

As it was found that there was increased overbite and decreased overjet to restore the tooth to normal function and esthetics, so it was planned to give a Richmond crown irt 21 to the patient after completion of endodontic treatment. The entire treatment plan was explained to the patient.

Under local anesthesia, root canal therapy was initiated under rubber dam isolation using split dam technique. In first appointment, the shade selection was finalized (Shade A2, Vita Classical, Germany) and access cavity was prepared by achieving a bur drop with a no.2 round bur (SS White, USA) after which, the roof of the chamber was removed completely with the help of an Endo Z bur (Dentsply Maillefer, Switzerland). The orifice was explored with the help of an Endo explorer (Dentsply Maillefer, Switzerland) probe. Initial negotiation into these canals was done using No. 15 hand K file (Mani, Japan). The initial apical file was found to a size of 45 hand k File (Mani, Japan) of which working length was determined with an apex locator (Canal pro, Coltene, Switzerland) and confirmed radiographically. The master apical preparation was made till 60 K Files (Mani, Japan) followed by the remaining part root canal was enlarged up to 80 k hand files using step back technique. Lastly a size 40 H file was used in circumferential motion to smoothen the canal. Close dressing with water-based calcium hydroxide (Neocal, Orikam, France) (Figure 4D) was placed into the canal and the patient is recalled after 10 days. On next visit, as the patient was asymptomatic and there was no evidence of discharge from the canal, obturation (Figure 4E) was carried out with cold lateral compaction technique and using Seal apex as a sealer (Kerr, USA). 17% EDTA gel was used as a lubricant during shaping and 5.25% sodium hypochlorite and 17% EDTA liquid were used as an irrigant. After obturation the access cavity was restored with temporary filling material (Neotemp, Orikam, France) & patient was recalled after 1month to access the healing of periapical radiolucency irt 21. After 1 month, as the periapical radiolucency was decreased in size (Figure 4F) than preoperative radiograph & as the patient was clinically asymptomatic the following steps were initiated for restoring the teeth.

Post space preparation- (Figure 4G)

Post space was prepared with Peeso reamer (Mani Inc., Tochigi, Japan) to remove coronal obturating material (care was taken not to disturb apical seal). The preparation part was ended with the use of H-file (Mani Inc., Tochigi, Japan) (circumferentially) to smoothen the walls, maintaining the divergence towards coronal root canal and to eliminate the undercuts into the post space

Crown structure preparation- (Figure 4H,4I)

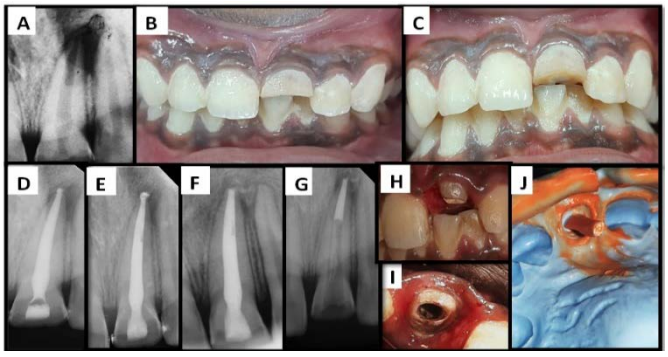
Firstly, remaining crown structure was prepared circumferentially for metal ceramic crown with Chamfer finish line given by TR 13 bur (Mani Inc., Tochigi, Japan).

Post and core fabrication (Indirect method)- (Figure 4J)

Canal was coated with light body impression material (Dentsply, Milford, USA) and then a small piece of serrated metal pin, coated with light body was placed in the canal. Later light body was injected around the prepared tooth, Heavy body putty impression material (Dentsply, Milford, USA) was loaded in stock tray and final impression is made and It was then poured with die stone and cast was obtained. The wax pattern (Figure 4K,4L) was made and checked on the cast for proper fitting.

Crown fabrication

After prepared post and core pattern was casted in base metal alloy, A try in was done in the patient's mouth for proper fitting into margins (Figure 4M,4N). A radiograph was taken to check the proper seating of the post and core & finally ceramic layering was done (Shade A2) over the core (Figure 4O). After checking for adequate margin adaption and aesthetics, the Richmond crown was cemented with glass ionomer cement (Figure 4P,4Q,4R) (GC Corporation, Tokyo, Japan).



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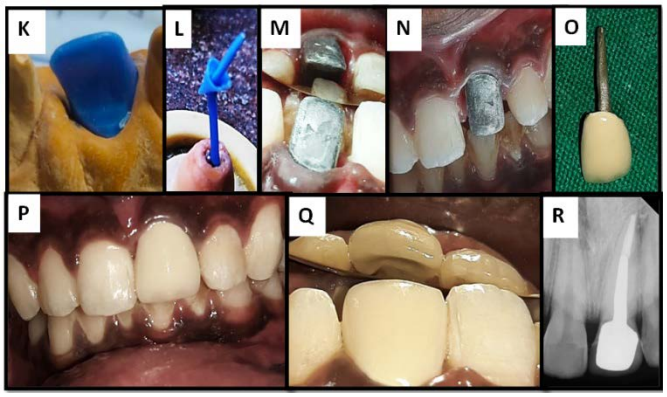

(B)

Figure 4-A: Pre-Operative radiograph & Clinical picture. C) Clinical picture showing deep bite & decreased overjet between 21 & 31 (upper & lower left central incisors) at maximum intercuspation due to labial tilt of left lower central incisor (31). D) Radiograph after 1st dressing change irt 21. E) Radiograph after obturation irt 21. F) Radiograph of 1-month follow-up after obturation irt 21. G) Radiograph after post space preparation irt 21.H & I) Clinical picture after crown cutting irt 21. J) Indirect impression irt

Figure 4- B: 21. K & L) Fabrication of indirect pattern for casting irt 21. M & N) Checking the interocclusal clearance & fitting of Metal casting irt 21. O) Ceramization over the metal core irt 21. P& Q) Clinical pictures after Richmond crown cementation irt 21. R) Radiograph after Richmond crown cementation irt 21.

Discussion

Endodontic treatment has been in practice since ages with high success rate but post-endodontic restorative part was not much emphasized previously. Whenever, a considerable amount of tooth structure is lost because of fracture/caries/secondary decay around previous restorations/during endodontic treatment, then remaining crown structure is not sufficient enough to retain large prosthetic crown.[5] In such cases special procedures are needed with objective to increase remaining crown length so that it manages arc of rotation under oblique

forces during function. In such compromised cases, the crown length can be increased with special procedures such as orthodontics extrusion and surgical crown lengthening. Surgical crown lengthening is indicated whenever there is esthetic and cosmetic need but disadvantage is it reduces root length and requires surgery with long healing period. Orthodontic extrusion also reduces root length and is time consuming too. Post and core procedure is most commonly used method for such cases. [6]

Various causes of failure of post-retained restorations have been identified, including: recurrent caries, endodontic failure, periodontal disease, post dislodgement, cement failure, post-core separation, crown-core separation, loss of post retention, core fracture, loss of crown retention, post distortion, post fracture, tooth fracture, and root fracture. Also, corrosion of metallic posts has been proposed as a cause of root fracture.[7-10]

The concept of increasing remaining crown structure (core) and strengthening it by using retention from root (post) is not new. In early 1700s, Fauchard inserted wooden dowels in root canal of tooth with the concept that over a period of time wood would absorb fluids and expand, resulting in enhancement of retention of post but excessive expansion was frequently causing root fractures. In the 19th century metal posts came into existence over which porcelain crowns were screwed.

The Richmond crown was introduced in 1878 and was incorporated as single piece post-retained crown with porcelain facing. Initially it was having a threaded tube in the canal with a screw retained crown, which was later modified to eliminate the threaded tube and was redesigned as a 1-piece cast dowel and crown.[1]

Indications of Richmond crown

1. Grossly decayed or badly broken single tooth where remaining crown height is very less and increases with steep incisal guidance (deep bite and very less overjet).
2. As less cervical tooth structure subjected to flexion forces under function and this design provides more cervical stiffening than other post systems and is needed to protect the crown margins and to resist leakage.

Advantages of Richmond Crown

1. Custom fitting to the root configuration.
2. Little or no stress at cervical margin.
3. High strength.
4. Availability of considerable space for ceramic firing and incisal clearance.
5. Eliminate cement layer between core and crown so reduces chances of cement failure.

Drawbacks of Richmond crown

1. This design had major flaw of not considering different longitudinal axis of root and crown as root and crown have different longitudinal axis and making them parallel require excessive cutting both for crown and root.
2. If ceramic fractures then it is difficult to retrieve and can lead to tooth fracture.
3. High modulus of elasticity than dentine (10 times greater than natural dentin),
4. The forces during function increases stresses at post apex causing root fracture.
5. More time consuming.
6. Required a greater number of appointments for patient.
7. High cost
8. Less retentive than parallel-sided posts,
9. Acts as a wedge during occlusal load transfer.

However, the long-term prognosis may be queried and other restorative procedures like ceramic repairing kit may be an alternative in cases of ceramic fracture.

The major drawbacks of Richmond crown led to development of a post and core restoration as a separate entity with an artificial crown cemented over a core and remaining tooth structure. This two-step technique improved marginal adaptation and allowed for a variation in the path of insertion of the crown.

In course of time till today, different designs/techniques/materials have been evolved. However, no single system provides the perfect restorative solution for every clinical circumstance, and each situation requires an individual evaluation. Although in present time the simplified "one-visit" prefabricated post is most commonly used, yet custom posts have their own advantages and indications so are still in use.

Richmond crown is not post and core system but it is customized, castable post and crown system as both are single unit and casted together. Design include casting of post and crown coping as single unit over which ceramic is fired and cemented inside canal and over prepared crown structure having same path of insertion. Ferrule collar is incorporated to increase mechanical resistance & retention of Richmond crown.

Even cases with steep incisal guidance are also subjected to more flexion forces along with very limited space for restoration. Such tooth if given with post and core first over which crown is cemented, needs adequate thickness which is a limitation here. To compensate this inadequacy if core is made thin then it is weak and also presents sharp margins and edges acting as stress points for overlying crown. Metal free crowns are predisposed to fracture whereas metal ceramic crowns tend to be a bulky crown in giving required thickness for metal coping and ceramic over it resulting in compromised esthetics. Richmond crown is best possibility in both these conditions as less crown cutting is required to make two axis parallel in grossly decayed tooth and also it require less thickness for best esthetic results. [1,11-13]

The clinician must judge every situation on its individual merits and select a procedure that fulfills the needs of the case while maximizing retention and minimizing stress. Although any number of post designs may be used in a clinical situation, success is dictated by the remaining tooth structure available after endodontic therapy.

Conclusion

This clinical case report describes the rehabilitation of two cases with marked erosion & fractured maxillary incisors with the Richmond crowns to improve the function and esthetics with a minimally invasive procedure. There are various other post-and core materials/ techniques available to the clinician for a variety of clinical procedures and thus each clinical situation should be evaluated on an individual basis. Richmond crown is very much indicated in situations with very less incisal clearance to accommodate core & cement along with crown thickness.

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