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Case Report

Designing a Richmond crown posssesing two different axial (root/core) inclinations

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***ABSTRACT*:**
Destruction of the coronal portion of natural tooth is a common occurrence in academic settings. Based on the understanding of biomechanical principles a clinician must assess the remaining tooth structure and decide the most appropriate restorative options. The use of richmond crown in various texts has remained that of historical interest. We present a case of an elderly female patient whose maxillary right central incisor had fractured horizontally five years back and had developed caries within the remaining tooth structure. The tooth besides being labially inclined had also a moderate degree of distal rotation developed as a result of loss of contacts. The most challenging aspect of the restoration was to achieve desired esthetics for the artifical porcelain fused to metal crown which were successfully achieved by a richmond crown.

Keywords: dental porcelain, base metal alloys, esthetics, phonetics,crown.

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Introduction

Traumatic injuries to the anterior teeth that result in their fracture is most commonly seen in dentitions where the teeth are proclined making them more vulnerable to be broken upon impact. With maxillary central incisors (80%) being more susceptible, [1] the immediate impact on aesthetics is profoundly psychological in nature. Restorations like artificial crowns in such cases are bound to fail if the intra radicular mean of retention is not utilized. The history of using the roots for retaining crowns has been found to be around 250 years old.[2] Till date the design of such restorations is essentially the same however, materials and techniques have changed with the passage of time. While the purpose of the post is to retain the external crown that is built on a core, the purpose of the core being to support the crown while itself being dependant on post for retention. While the present day post core crowns are essentially either a two or three unit system (Post, core, crown), they have essentially evolved from a single unit system called the Richmond crown which was introduced in the year 1878 as a single piece post retained crown with porcelain facing.[3] While the current porcelain fused to metal technique was introduced much later, it is understandable that the original richmond crown of 1878 had to use a screw to retain the crown to the threaded tube within the root, [3] since facings of porcelain and metal were attached in a similar way for complete dentures. The original Richmond crown of the year 1878 was based on the design developed by Clark in mid 1800. Clarks design had a key focus on being to provide drainage within a post core system since most of restorative designs were limited by the failure of the " endodontic " therapy during that era. [4] The Richmonds crown of 1878 was designed to retain a bridge and incorporated a threaded tube in the root canal to which a crown was retained using a screw. [5] with the introduction of acrylic resin, the porcelain facing of the original Richmond crown was then modified while the skeleton

(hard gold) consisting of two wings was supported by a Y shaped backing.[6] while the design was primarily meant to bridge, its use in bridge cases with divergent paths of insertion and removal between the post space and adjacent tooth limited its application. This paved way for elimination of the threaded tube into a single piece dowel and crown.[5]

Because the axial inclinations of the root and the crown of the natural tooth are not identical, a Richmond crown essentially lost popularity since it did not fulfil such norm. However, we report a case of a fractured maxillary right central incisor in an elderly female patient to essentially highlight the fact that a Richmond crown can be essentially fabricated with different axial inclinations between the post and the core. Such design can also overcome the lacunae of restoring natural roots which provide equigingival or mild subgingival finish lines.

Case report

A female patient aged 58 years was referred from the department of endodontics to the post graduate section of the department of prosthodontics for a professional opinion. The possibility of restoring a grossly fractured crown of maxillary right central incisor was to be decided since the caries could be subgingival, the tooth had migrated with a pronounced labial component. Patients medical, social, drug and other related histories were irrelevant to current dental condition or treatment. The patient had broken the tooth 5 years back while playing with her granddaughter and had not sought treatment till she had developed pain recently. Features of pain were typical of a peri apical abscess. Extra oral examination revealed normal features except with a high lip line with an increased exposure of maxillary anterior teeth **(Fig 1A)**. Intra oral examination revealed a class 1 molar relation with a full complement of natural teeth **(Fig 1B)**. Except the signs of occlusal wear and migration of anterior teeth, there were no obvious signs of pathogenic occlusion (periodontal, alveolar, joint, muscle). Due to loss of proximal contacts of maxillary right central incisor, both adjacent teeth had pushed the fractured crown labially. The maxillary left central and lateral incisor both showed prominent signs of the effect of the loss of proximal contacts **(Fig 1C)**. Functional occlusal examination revealed decreased overjet and increased overbite, functional anterior guidance with maxillary left central incisor and canine in contact during protrusion and a functional canine protected occlusion during lateral mandibular movements. Treatment options presented to the patient included a conservative option of restoration with a post core crown after endodontic treatment and a non conservative option of extraction of maxillary right central incisor followed by placement of an implant supported crown. The patient consented for the conservative approach. Endodontic treatment of the concerned tooth was done in multiple stages and after determining its success, the restorative phase was started by using routine clinical and laboratory steps for post core fabrication. A full arch maxillary and mandibular diagnostic impressions using irreversible hydrocolloid (CA 37; Cavex, Haarlem, Holland) were made followed by mounting maxillary diagnostic casts on a semi adjustable articulator (Hanau Widevue,Waterpik, Ft Collins,CO, USA) using an arbitrary face bow (Hanau). The mandibular casts were mounted using a centric relation interocclusal record (Take 1, Kerr, Romulus, MI, USA) while the articulator was programmed using a protrusive record with the same material.

The postspace was prepared by removing the gutta percha using gates glidden drills (Nordin, stainless steel, Switzerland) followed by actual preparation for the post space using Pesso reamers (Nordin, stainless steel, Switzerland). The post space was prepared using ideal norms with no attempt to change the axial inclination of the preparation. The feature of the coronal preparation was to provide a ferrule without extending the feature labially. In effect the ferrule effect on the labial side was provided by the finish line of the final crown. This was done to accommodate the loss of tooth structure labially and provide a laboratory technician to change the axial inclination of the core. Indirect techniques for fabricating Richmond crown was done that included gingival retraction (Ultradent, South Jordan, UT, USA), definitive impressions with elastomeric impression material (Affinis; Coltene AG, Altstatten; Switzerland) and mounting maxillary master cast using a face bow index. Wax pattern for post and the core was fabricated of inlay wax (Harward, Germany) which was later cast into a porcelain compatible base metal alloy (Remanium CSe, Dentaurum J.P. Winkelstroeter KG, Ispringen, Germany). The key feature of the wax pattern was different inclinations for the root portion and different inclination for the core portion. While the post inclination was determined by the root preparation, the core inclination was determined by the labial surfaces of adjacent maxillary incisors. The cut back of the wax pattern was limited to the proximal and lingual aspects while the labial cutback was determined during clinical trial **(Fig 2 A).**

Figure 1: (A) Extra oral view showing high lip line (B) Intra oral view showing labially inclined fractured central incisor (C) Occlusal view showing the effect of the loss of contact with rest of anterior teeth.

During the clinical trial, the labial inclination of the core was adjusted so as to provide enough thickness for labial porcelain to achieve proper aesthetics **(Fig 2 B)** . An intra oral peri apical radiograph was used to verify the fit of the post **(Fig 2 C).** Porcelain shades were selected using 3D Master (Vita Zahnfabrik, Badsackingen, Germany) and respective shades of porcelain were fused and evaluated on the master cast **(Fig 2 D)** with key focus being on the labial contour. After glazing the final single unit post core was ready for final cementation **(Fig 2 D).** The final restoration was cemented in place using zinc phosphate cement (Harvard, Germany) **(Fig 2 E)** . The patient was put on a follow up and claimed to be extremely satisfied with the esthetic outcome of the restoration.

Figure 2: (A) Metal framework with different core inclination (B) Metal framework during clinical trial. The cervical portion requires creation of additional space for the porcelain thickness (C) IOPA of non cemented Richmond core (D) Porcelain addition (E) Finished Richmond crown a single unit post, core and crown (F) Extra oral view after cementation of the prosthesis.

Discussion

A case of an elderly female patient whose fractured tooth complicated with caries, labial displacement with distal rotation in the presence of a deep bite and decreased overjet was successfully restored with a single unit post core crown. The key feature of this rehabilitation being incorporation of two different axial inclinations (one for the root portion or post and the other for the core portion) within the single unit Richmond crown. Conventional post and core restorations are classified as prefabricated and custom made. [7] Any of these can be either active or passive depending upon the relation of the post with the preparation within the root canal. While post core crowns are a mere measure to enhance the strength of the remaining tooth structure, the longevity of such restorations still depends upon the amount of remaining natural tooth structure that is present and the way restorative procedure has been carried out effectively.[8] Richmond crown essentially is a design and can be given on any natural tooth provided one is able to weigh its advantages in such particular situations. Its primary advantage over conventional separate post core and crown is its use in case of deep bite (increased overbite) and decreased overjet. In such cases the horizontal forces applied to a restoration complex are increasing both in magnitude as well as duration, from the mandibular incisal edge contacts the palatal surface of maxillary teeth for a longer period of time **(Fig 3)**. Increased forces are mainly related to the decreased distance between the center of rotation of a tooth and the point of contact (point A to C in normal overjet/overbite and point B to point C in deep bite cases) **(Fig 3)**. In such clinical situations a post core with additional interface between the core and the crown is liable to undergo cement failure for the magnitude and duration of tensile forces are increased.

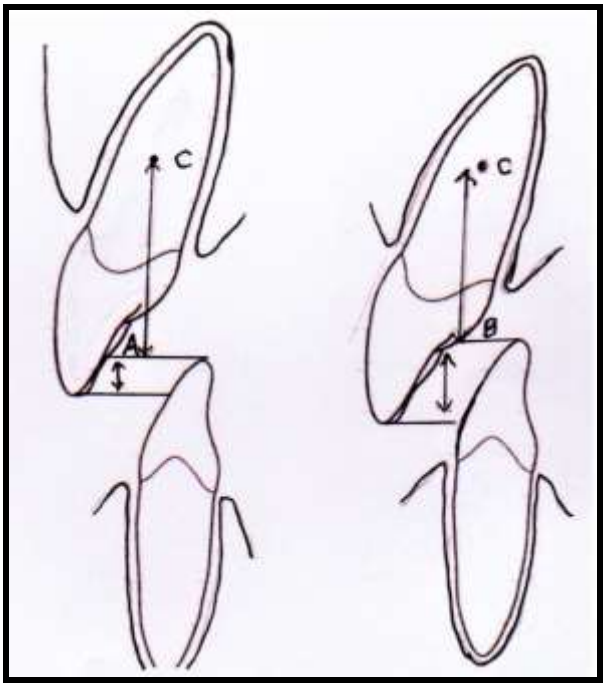

Figure 3: Relation between the amount of overjet/overbite at two different positions (normal and deep bite) with the center of rotation of a tooth

Richmond crown eliminates the core – crown – cement interface, thus minimizing or eliminating the chances of cement failure under tensile load. A deep bite also places the dislodging force (mandibular incisal edge) near or under the margin of the restoration making dislodging of the crown easier.

Various forms of Richmond crown have been attempted by various authors in different clinical situations. While most of the cases have been done on the maxillary anterior teeth, [9,10] Sangur R restored a posterior tooth (mandibular second premolar) suggesting application of Richmond crowns in the posterior region.[11] Application of the principle of Richmond crown has also been reported by Prashanth et al, who fabricated a hybrid prosthesis in which natural tooth fragment was reattached in an 18 year old male patient. The difference being they used a prefabricated post (Parapost) rather than a customized post core system. All cases that have been reported have modified ferrule according to the individual clinical situation.

Clinical applications of a single unit Richmond crown have been summarized in Table 1. One of the drawbacks of a Richmond crown that has been mentioned in the literature that more tooth reduction is needed to keep the

same axial inclination between the post and the core. However, this is true if the post is a prefabricated one. With custom made post core the axial inclination between the two can be kept different according to a particular clinical situation. We found Richmond crown to be particularly beneficial when fractures or caries have reached the level of the gingiva or even gone subgingival. Since the ferrule can be achieved in Richmond core either with one of the finish line on the crown or even within the core, the use of Richmond crown should be done more often where teeth are advised to be extracted on the basis of inability to place ferrule either labially or lingually. Another important consideration before advising tooth extraction is the analysis of forces on that particular tooth (anterior guidance, occlusal forces). Most of the anterior teeth do not undergo through high amount of compressive or tensile forces and can be restored for a long time with options like Richmond crown.

Conclusion

Richmond crown when introduced was based on a prefabricated post core system, in which it was mandatory to remove the more natural tooth structure to match the axial inclination of the post with the core. With the use of a custom made cast post and core, one can easily overcome this lacunae in the Richmond core system.

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Table 1: Clinical applications of a single unit Richmond crown

Indications 1. Grossly decayed/fractured single tooth that results in decreased crown height 2. Steep incisal guidance (deep bite and/or decreased overjet) 3. Desired porcelain thickness cannot be achieved by conventional two unit post core and a crown 4. When the feature of ferrule for both core and crown cannot be achieved 5. Decreased occlusal clearance or restorative space
Contraindications 1. When the restored tooth participates actively in providing anterior guidance 2. Excessive horizontal forces on the tooth to be restored during protrusion or lateral excursion
Advantages 1. Reduces possibility of restoration leakage 2. Less tooth preparation required (no need of making two axis parallel) 3. Custom root configuration fitting 4. Reduced cervical margin stress 5. High strength 6. Increased labial and incisal clearance to achieve desirable porcelain thickness 7. Elimination of the cement layer between core and crown thus reducing chances of cement failure 8. Eliminates problems that may result due to differences in coefficient of thermal expansion between various parts of post core system 9. Monoblock restoration eliminating failures due to flexion of posts under functional stresses
Disadvantages 1. Technically incorrect design since root and crown have different axial inclinations 2. Excessive tooth reduction required if and when the axial inclination of the root is made parallel with the axial inclination of the core 3. Time consuming 4. Additional clinical procedures as compared to prefabricated post core crown, thereby increasing the cost 5. Difficult to retrieve if ceramic fractures