



Geometrical Salvage of Split Tooth

Supratim Tripathi¹, Hena Rahman^{1*}, Ramesh Chandra¹,
Shailja Singh¹, Payal Tripathi¹, Shoyab Khan² and Hemant Mathur³

¹Department of Conservative Dentistry and Endodontics, Career Post Graduate Institute of Dental Sciences and Hospital, Lucknow, India.

²Department of Orthodontics, College of Dentistry Salman Bin Abdulaziz University, Al- Kharj, Saudi Arabia.

³Department of Oral Medicine and Radiology, Pacific Dental College & Hospital, Udaipur, Rajasthan, India.

Authors' contributions

This work was carried out in collaboration between all authors. Authors ST and HR designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors RC, SS and PT managed the literature searches. Authors SK and HM managed the follow-up of the case. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2015/14708

Editor(s):

- (1) Ibrahim El-Sayed M. El-Hakim, Ain Shams University, Egypt and Riyadh College of Dentistry and Pharmacy, Riyadh, Saudi Arabia.
(2) Chan Shen, Department of Biostatistics, MD Anderson Cancer Center, University of Texas, USA.

Reviewers:

- (1) Gaurav Solanki, Jodhpur National University, Jodhpur, India.
(2) Anonymous, India.
(3) Anonymous, Greece.
(4) Anonymous, Malaysia.
(5) Abiodun-Solanke I. M. Funmilayo, Restorative Dentistry, University of Ibadan, Nigeria.
Complete Peer review History: <http://www.sciencedomain.org/review-history.php?iid=947&id=12&aid=8420>

Case Study

Received 15th October 2014
Accepted 21st February 2015
Published 12th March 2015

ABSTRACT

Aims: Management of vertically fractured mandibular first molar by intra coronal splinting applying the finite centre of rotation effect of Pythagorus theorem.

Case Presentations: A 28 year old male patient presented at the Department of Conservative Dentistry and Endodontics with the chief complaint of pain in the lower right back region of the mouth since last the 10 days. Past dental history revealed that affected tooth had root canal treatment done two years ago. History of present illness was that pain was elicited on chewing, and applying pressure on that area, with occasional bleeding from the same region. Intraoral examination revealed that tooth 46 was tender on percussion with vertically fractured crown in

*Corresponding author: Email: henavns@gmail.com;

mesiodistal direction. Periapical Radiograph revealed that tooth was endodontically treated, with radiolucencies at apical and furcal area, and visible fracture line in mesiodistal direction at CEJ level.

Technique Used in the Study: The tooth was endodontically retreated and Pythagoras theorem was used to locate the centres of rotation on both buccal and lingual sides of tooth 46 coronally. The technique was followed by drilling a vent at the same position approximating a fibre post (3M, Relyxfibre post). The centres were different both for buccal and lingual aspects which when approximated will provide antirotation. The post was placed in the buccolingual direction and the tooth was restored with posterior composites after which the restoration was checked for any high points. Follow up of the case was done for the period of one year.

Discussion: The concept of the estimation of the finite centre of rotation is like the primary objective in tightening a screw joint to generate an optimum preload that will maximize the fatigue life of the screw while offering a reasonable degree of protection against loosening. The major advantage of this approach is that the fragment was stabilized properly and there was healthy development of periodontium over the year.

Conclusion: Usually the vertically fractured tooth have poor prognosis and may likely be referred for extraction if not stabilized properly. This case report emphasizes the basic concept of stabilization and preventing rotation around an axis which will give the fractured tooth a better longevity and avoid the vibrations during crown preparation. The combined effect will restore the patient's own natural tooth back and minimizes the chances of periodontal complication.

Keywords: *Pythagoras theorem; FCR (Finite Center of Rotation); vertical tooth fracture; intracoronal splinting; adhesive technique.*

1. INTRODUCTION

The term 'Cuspal fracture odontalgia' was first described by Gibs in 1954 for cracked teeth [1]. Ritchey et al in 1957 reported cases of incomplete fracture with subsequent pulpitis [2]. Cracked teeth and their related entities, as well as vertical root fractures are longitudinal fractures of the crown and /root. These fractures occur in all teeth but are commoner in premolars and molars. The predisposing factors for cracked teeth include occlusal forces and dental procedures such as root canal therapy. Intermittent pain on biting is the most consistent complaint associated with these teeth. Cracks in teeth may result in a wide range of symptoms ranging from occasional discomfort to severe and prolonged pain [3]. Symptoms are often dependent on the depth and direction of the crack and the tissues involved. Thus in order to avoid the movement of the fractured tooth fragment, Finite Centre of Rotation (FCR) analysis was used. The FCR is a common measurement used for clinical diagnosis of joint function. The FCR is often used as an approximation to the centre of rotation of a joint, and can be defined as the point which is unchanged by a rigid transformation involving a translation and a rotation [4]. The primary goal is to splint and stabilize a cracked tooth to prevent further extension or complete fracture of the tooth [5,6].

American association of Endodontists classify cracked teeth as – (i) Cuspal fractures, (ii) Cracked teeth, (iii) Split tooth and (iv) Vertical root fracture [7].

The aim of the present case report is to splint and stabilize the cracked tooth fragment, prevent further destruction of periodontal space and to restore the tooth back to form and function.

2. PRESENTATION OF CASE

A 28 year old male patient reported to the Department of Conservative Dentistry and Endodontics complaining of 10 days history of pain in the lower right back region of mouth. Past dental history revealed that the affected tooth had root canal treatment done two years ago.

History of present illness revealed that pain was elicited on chewing food, applying pressure on that area and there was associated bleeding occasionally from the same region. Intraoral examination revealed that the tooth 46 was tender on percussion and vertically fractured crown in mesiodistal direction. The fragment on the buccal aspect was mobile (Fig. 1).

Periapical Radiograph revealed that the tooth was endodontically treated with radiolucencies at apical and furcal areas, along with visible fracture line in mesiodistal direction at CEJ.

Root canal retreatment was planned along with stabilization of fractured segments immediately. For retreatment procedure temporary restoration was removed with hand instruments, access cavity cleaned with normal saline and GP (gutta-percha) were removed from canal with the help of H-files and GP solvent Endosolv (Septodont). Canals were cleaned with normal saline and chlorhexidine and checked for any exudates or signs of inflammation, then prepared and obturated with GP using lateral condensation technique in the same appointment. Finally, the canal orifices were sealed with Glass ionomer cement (3M Restorative).

For stabilizing fractured segments Pythagoras theorem was used to locate the centres of rotation on both buccal and lingual sides. Reference points were marked on the highest

points on the cusps and on the cervical margin. Applying the theorem ($A^2+B^2=C^2$) centre of the length was computed which was the finite centre of rotation. Side A was taken as the measurement taken from mesiobuccal cusp tip to distal cusp tip (Fig. 2(a)), Side B was taken as the measurement taken from mesiobuccal cusp to the cervical reference point (Point of the joining of the artificial line from the mesiobuccal cusp tip to the cervical area, Fig. 2(b)) and Side C was the diagonal which was achieved by Calculating the two sides (Fig. 2(c)). Similarly on lingual side, side A corresponds to measurement taken from mesiolingual cusp tip to distobuccal cusp tip (Fig. 2(a)). Side B was measurement from mesiolingual cusp tip to cervical reference point (Fig. 2(b)) and side C was calculated using formula ($A^2+B^2=C^2$).



Fig. 1. Showing fractured tooth no 46 (a) mobile buccal fragment (b) pre-operative intraoral periapical radiograph (c) working length determination after removal of GP points



Fig.2. (a) Marking the cusp tips (b) Measurement of dimensions (c) Drilling at the center of rotation

The center of rotation for human joints in two-dimensions is a kinematic variable which is popular for the assessment of joint function. The center of rotation is normally represented by the finite center of rotation (FCR) which relates to a measure taken from a single finite displacement [8]. The technique was followed by drilling a vent at the same position approximating a fibre post (3M, Relyxfibre post). The centre was different both for buccal and lingual segments which when approximated will provide antirotation. The post was placed in the buccolingual direction and the tooth was restored with posterior composites after which the restoration was checked for any high points (Fig. 3).

The case was kept under observation for one year. Post-operative follow up radiograph showed reduction of bone loss and the patient did not complain of any pain post operatively (Fig. 4). There was no sign of any change occurring neither at the tooth to the fragment interface and nor with the parodontal apparatus; thus the tooth was given the final restoration in the form of full metal crown (Fig. 6).

3. DISCUSSION

Fractures are the third most common cause of tooth loss. Thus, it is of utmost importance to avoid or eliminate risk factors which contribute to tooth fracture. The key factor is early diagnosis and treatment of the crack so that they can be halted or their progression slowed down. However, a cracked tooth is a compromised tooth even with proper treatment [9]. Although treatment recommendations should be made on an individual basis, the association between crowns and the survival of root canal treated teeth should be recognized during the treatment planning if long-term tooth survival is the primary criteria for success in endodontics [10].

According to iadt (international association of dental traumatology) guidelines [11], treatment modalities for sub gingival fractures with pulp exposure are discussed under following headings – (i) emergency treatment- as an emergency treatment a temporary stabilization of loose segment to adjacent teeth.

In patients with open apices, it is advantageous to preserve pulp vitality by a partial pulpotomy. This is the treatment of choice in young patient with incompletely formed teeth. In patients with mature apical development, root canal treatment can be the treatment of choice.

(ii) Non-emergency treatment alternatives

- Fragment removal and gingivectomy (sometimes ostectomy)
- Orthodontic extrusion of apical fragment
- Surgical extrusion
- Root submergence
- Extraction with immediate or delayed implant-retained crown restoration or a conventional bridge.

For stabilization of fractured fragment; permanent stabilization can be achieved with an adhesive intracoronal restoration e.g., bonded amalgam, adhesive composite restorations, fibre reinforced composites or a cast extra coronal restoration e.g., gold and porcelain inlays, onlay or three-quarter crown with adequate cuspal protection, and full-coverage crowns [12-15].

Application of pythagoras theorem to determine centre of rotation of mobile fragment and joining it with fixed lingual segment through fiber post followed by permanent restoration for intracoronal stabilization is depicted in Fig. 5.



Fig. 3. (a) Restoration with composite (b) Removal of fibre post (c) Removal of high points



Fig. 4. (a) 6 months follow up (b) new bone formation (c) one year follow up

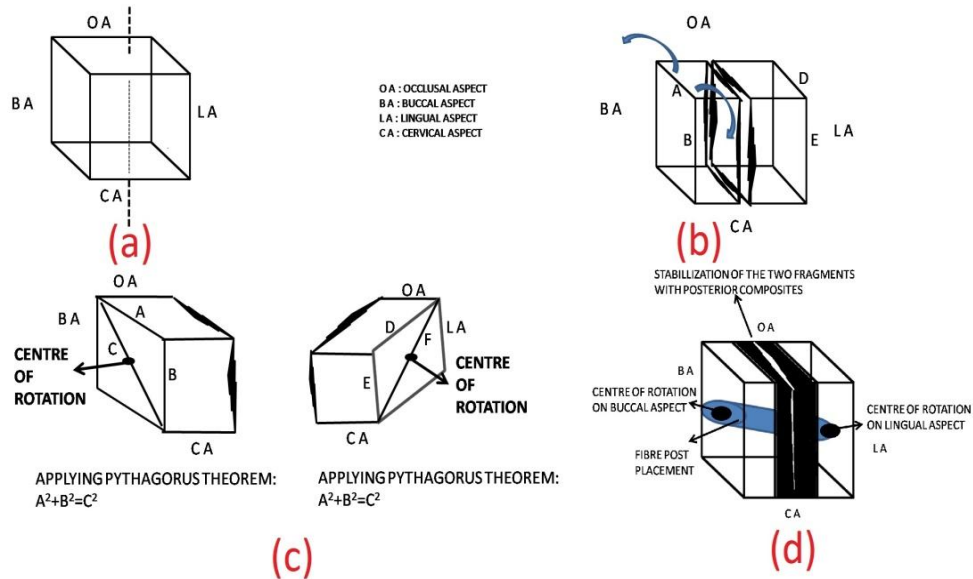


Fig. 5.(a): Cubical block representing Coronal Fragment with fracture in mesio distal direction, (b): Mobile fragment on the buccal aspect and stable lingual fragment, (c) Location of centre of rotation on the Buccal and lingual aspect by application of Pythagorus Theorem, (d) Placement of fibre post from the Bucco-Lingual direction through the centre of rotation which shifted the finite centre from the mobile fragment to the immobile fragment thus stabilizing the tooth



Fig. 6. Showing full cast metal crown after a year follow-up

The concept of the estimation of the finite centre of rotation can be compared with the primary objective in tightening a screw joint which is to generate an optimum preload that will maximize the fatigue life of the screw while offering a reasonable degree of protection against loosening [16,17].

The purpose of preload is to generate an adequate clamping force which keeps two component parts together and attains stability across the joint [18]. When the total external load experienced by the screw is greater than the yield strength of the screw, the protection afforded by the preload is lost and the potential for screw loosening and/or fracture occurs [16]. Optimum preload will maximize the fatigue life of a screw and offer a reasonable degree of protection against loosening [16,18].

Split tooth fractures are primarily mesiodistal fractures that cross both marginal ridges and extend deep to shear onto the root surface [1].

This method showed a simpler derivation for calculating the angle of rotation of a set of marker points undergoing rigid planar rotation and translation. The major advantage of the approach is that the fragment is stabilized properly and there was healthy development of peridontium over the year [6] after which the tooth was given a metal crown. Metal prosthesis requires minimal reduction of the tooth and provides maximum strength. An immediate intervention such as described above can improve the chances of saving the tooth when a crack is suspected and thereby provide the best esthetics.

4. CONCLUSION

The tooth with fracture might go for extraction if not stabilized properly. This case report emphasizes the basic concept of stabilization and preventing rotation around an axis which will give the tooth a better longevity and avoid the vibrations during crown preparation. The combined effect will provide the patient his own natural tooth back and minimizes the chances of periodontal complication.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

An ethical approval was obtained from institution's ethical committee to carry out the procedure.

ACKNOWLEDGEMENTS

This study was supported by all the staff members of department of Conservative Dentistry and Endodontics, CPGIDSH, Lucknow, U.P., India.

COMPETING INTERESTS

Authors have declared that no competing interest exists.

REFERENCES

1. Jyothi KN. Management of vertically fractured maxillary second molar. *J Dental Sciences & Research*. 2010;1(2):45-50.
2. Gibbs JW. Cuspal fracture odontalgia. *Dent Digest*. 1954;60:158-160.
3. William Kahler. The cracked tooth conundrum: Terminology, classification, diagnosis and management. *Am J Dentistry*. 2008;21(5):275-282.
4. Mc Cane B, Abbott JH, King T. On calculating the finite centre of rotation for rigid planar motion. *Medical Engineering & Physics*. 2005;27(1):75-79.
5. Ritchey B, Mendenhall R, Orban B. Pulpitis resulting from incomplete tooth fracture. *Oral Surg*. 1957;10:665-670.
6. Cameron CE. Cracked-tooth syndrome. *J Am Dent Assoc*. 1964;68:405-411.

7. *Endodontics* colleagues for excellence. cracking the cracked tooth code: detection and treatment of various longitudinal tooth fractures. 2008;Summer:1-8. Available:https://www.aae.org/uploadedfiles/publications_and_research/endodontics_colleagues_for_excellence_newsletter/ecfe_sum08.pdf
8. John H. Challis. Estimation of the finite center of rotation in planar movements. *Medical Engineering & Physics*. 2001;23(3):227–233.
9. Mittal N, Sharma V, Minocha A. management of cracked teeth - A Case Report. *Endodontology*. 2007;19(1):39-44.
10. Tikku AP, Chandra A, Bharti R. Are full cast crowns mandatory after endodontic treatment in posterior teeth. *J Conserv Dent*. 2010;13(4):246–248.
11. Diangelis AJ1, Andreasen JO, Ebeleseder KA, Kenny DJ, Trope M, Sigurdsson A et al. International association of dental traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations of permanent teeth. *Dent Traumatol*. 2012;28(1):2-12.
12. Bremer DB, Geurtsen W. Fracture resistance of human molars after adhesive restoration with ceramic inlays or composite resin fillings. *Am J Dent*. 2001;14:216-220.
13. Geurtsen W, Garcia-Godoy F. Bonded restorations for the prevention and treatment of the cracked-tooth syndrome. *Am J Dent*. 1999;12:266-270.
14. Trushkowsky R. Restoration of a cracked tooth with a bonded amalgam. *Quintessence Int*. 1991;22(5):397-400.
15. Davis R, Overton JD. Efficacy of bonded and nonbonded amalgam in the treatment of teeth with incomplete fractures. *J Am Dent Assoc*. 2000;131(7):848-52.
16. Lee SM, Lin SY, Wang MT, Wang SJ, Lin DL. Effect of anti-rotational design and countertorque device on peri-implant bone stress during and after preload – a preliminary results. *J Prosth & Implantology*. 2013;2(2):11-15.
17. Haack JE, Sakaguchi RL, Sun T, Coey JP. Elongation and preload stress in dental implant abutment screws. *Int J Oral Maxillofac Implants*. 1995;10:529-36.
18. Sakaguchi RL, Borgersen SE. Nonlinear contact analysis of preload in dental implant screws. *Int J Oral Maxillofac Implants*. 1995;10:295-302.

© 2015 Tripathi et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sciencedomain.org/review-history.php?iid=947&id=12&aid=8420>