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Full Length Research Paper

Esthetic and functional rehabilitation of soft-drink eroded teeth with prosthodontic approach: A case report

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Dental caries and enamel erosion are among the several health problems related to unusual consuming of soft drinks as an extrinsic factor of dental erosion. In this report, a 27-year-old man complaining of severe worn-out of all his teeth was presented. He had a history of unusual drinking of cola (4 to 6 L daily) for 6 years and had a poor oral hygiene. Severe decays were present in the incisors, canines, premolars, and molars. Counseling about healthy nutrition and drinking was used as an important aspect of management plan. Conservative management of dental caries was performed and during 3-year follow-up including counseling about nutrition and oral hygiene, the patient had no complaint related to the dental management. To prevent dental erosions related to drinking, it is necessary to increase awareness of people about public health problem related to the adverse effect of excessive soft drink consumption. For the long-term success of dental restoration as the presented case, the maintenance of lifestyle changes and regular follow-up are the most important factors to prevent the deterioration of dental health.

Key words: Dental erosion, soft drinks, prosthodontics, cola, acid.

INTRODUCTION

Dental erosions are defined as a loss of dental hard tissue caused by acid in contrast to caries without bacterial involvement (Trushkowsky and Garcia-Godoy, 2014). They may occur on all accessible dental surfaces, triggered by extrinsic or intrinsic factors (Hellwig and Lussi, 2014). The frequent use of acidic medications that come in direct contact with teeth has also been identified as an extrinsic etiologic factor in dental erosion, not only for adults but also for children and adolescents (Salas et

al., 2015). Marked increases in dental erosion have been noted in some countries to be due to an increased consumption of acidic drinks, and dental erosion in children has thus aroused considerable clinical interest (Johansson et al., 2012). Several case-control and observational clinical studies in adults and children, have shown a clear variable relationship between gastroesophageal reflux disease and tooth erosion (Ranjitkar et al., 2012).

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Figure 1. Dental images before prosthodontic treatment. (a) Aesthetic appearance of the teeth lost. (b) The image after Erosion occlusion of the maxilla and mandible. (c) The occlusion to the right of the image. (d) Occlusion of the left image. (e) Detailed image of the maxilla. (f) Detailed image of the mandible.

There are two factors increasing the risk of tooth decay related to excessive soft drinks. These factors will lead to changes in pH. Sugar is easily fermented by bacteria in the mouth (Kleinberg, 2002). Phosphoric acid in coke weakens the tooth enamel and increases the risk of caries (Tahmassebi et al., 2006). However, the high sugar concentration prepares an appropriate environment for bacteria (Marsh, 2003). The effect of diet on dental tissue can be affected by a number of factors such as corrosive acid environment and hot drinks (Wongkhantee et al., 2006). Related to many of these variables, limited information is available (Ganss et al., 2012).

Huysmans et al. (2011) found in their study that erosive wear linked to tooth erosion is defined as loss of tissue and stated that while the chemical process was related to "dental erosive wear", clinical process deal with the external view. Erosions are usually observed on the facial, lingual and occlusal surfaces of the teeth (Grippio et al., 2004). Anatomical and functional factors affect the anterior teeth in the early period; this localization is another important reason for exposition of dentin

(Fonseca et al., 2008). In a relevant study, it was demonstrated that cola and orange juice reduced the surface hardness of tooth enamel in accordance with the daily-consumed food and beverages (Edwards et al., 1998).

In this paper, a case of dental erosion and severe caries caused by excessive consumption of soft drinks was reported.

CASE REPORT

Written informed consent of the patient was obtained for this case presentation. A 28 year-old male patient with bad breath, lack of chewing, and speech difficulty, was admitted to our prosthodontic service with aesthetic problems. Intraoral examination revealed many teeth of the mandible and the maxilla eroded (Figure 1).

After obtaining a detailed history of the patient, the cause of erosion was considered as related to the acid content in the diet. There was no history of gastro-

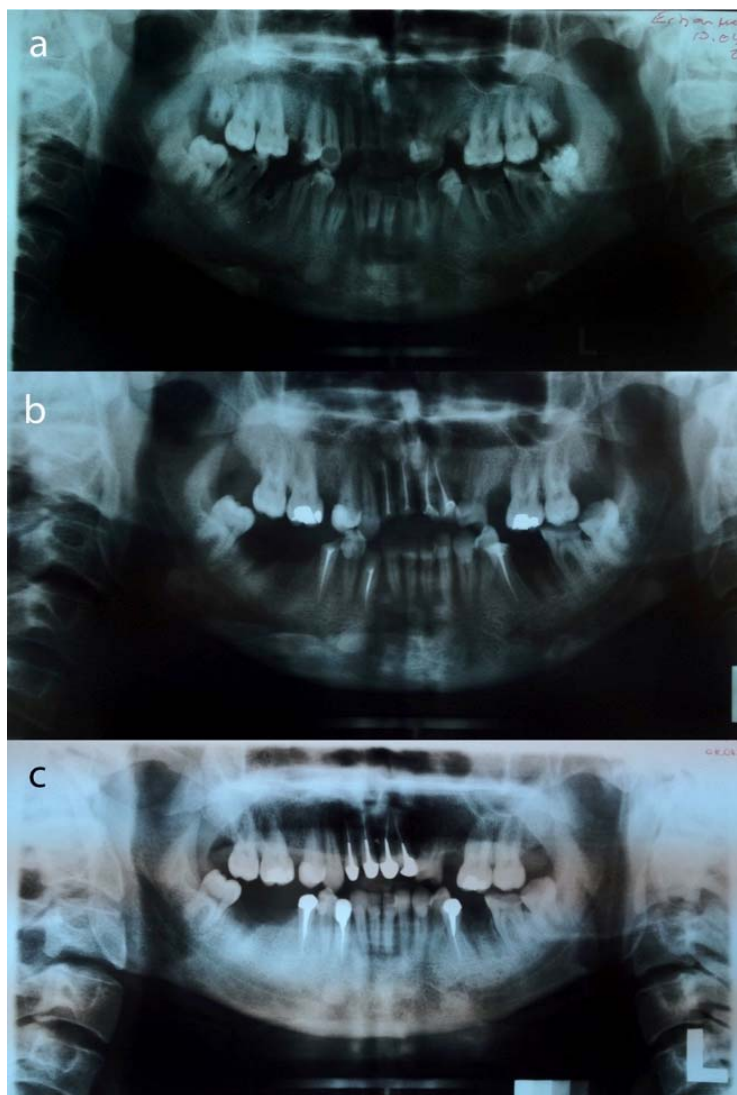


Figure 2. Dental radiographs while continuing of prosthodontic treatment. (a) The first examination radiography of the patient. (b) Post-radiographic image after root canal treatments and tooth extractions. (c) Radiographic image the after post-core applications.

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
							R	L							

Figure 3. FDI (World Dental Federation) classification for teeth.

esophageal reflux disease and drug use of systemic disorders. The patient was informed against the excessive drinking of cola. In the context of diagnostic workup, panoramic radiographs of the patients were

taken (Figure 2).

Pulp vitality tests were performed for all teeth. According to FDI classification (Figure 3), root canal treatment was performed to severely eroded and devital



Figure 4. Dental images after 2 year the prosthodontic treatment. (a) The patient's aesthetic design image. (b) Treatment of anterior images. (c) Closing the right image after the treatment. (d) Closing the left image after the treatment. (e) Detailed image of the maxillary teeth after treatment. (f) Detailed image of the mandibular teeth after treatment.

teeth including 11, 12, 21, 22, 34, 43, and 45 and extraction was required for teeth 15, 25, 36, 46, and 47 that could not be saved. In the unhealthy teeth, there were apical lesions and periodontal withdrawal. After root-canal treatment of teeth, post-operative follow-up examination revealed no complication and uneventful recovery. Post-core treatment was performed on the root canal of the teeth. Prosthodontic treatment was planned. Because of the aesthetic requirements of anterior regions, the zirconium-enabled ceramic crowns were performed on anterior teeth, while metal-ceramic crowns and bridges were performed on the posterior teeth (Figure 4).

The patient was followed up for 5 years. Periodontal, endodontic, and prosthetic examinations were made (Figure 5) periodically. Follow-up examinations revealed that the patient did not drink cola irresponsibly as well as

he ate acidic food according to the dietary suggestions. Patient had no complaints related to chewing and speaking.

DISCUSSION

Citric acid is added to many commercially produced drinks (diet coke, etc) (Kitchens and Owens, 2007). High citric acid has a potential for erosive effects (Lussi et al., 2012). In terms of dental health, critical pH level is 5.5 and phosphoric acid has a pH level below 5.5 (Dawes, 2003). Diet coke has higher pH value than those with the regular form (McCloy et al., 1984). In the presented case, teeth erosion of the patient was considered as a result of excessively consumed diet coke with a low pH value. In addition, the high concentration of sugar in the coke may

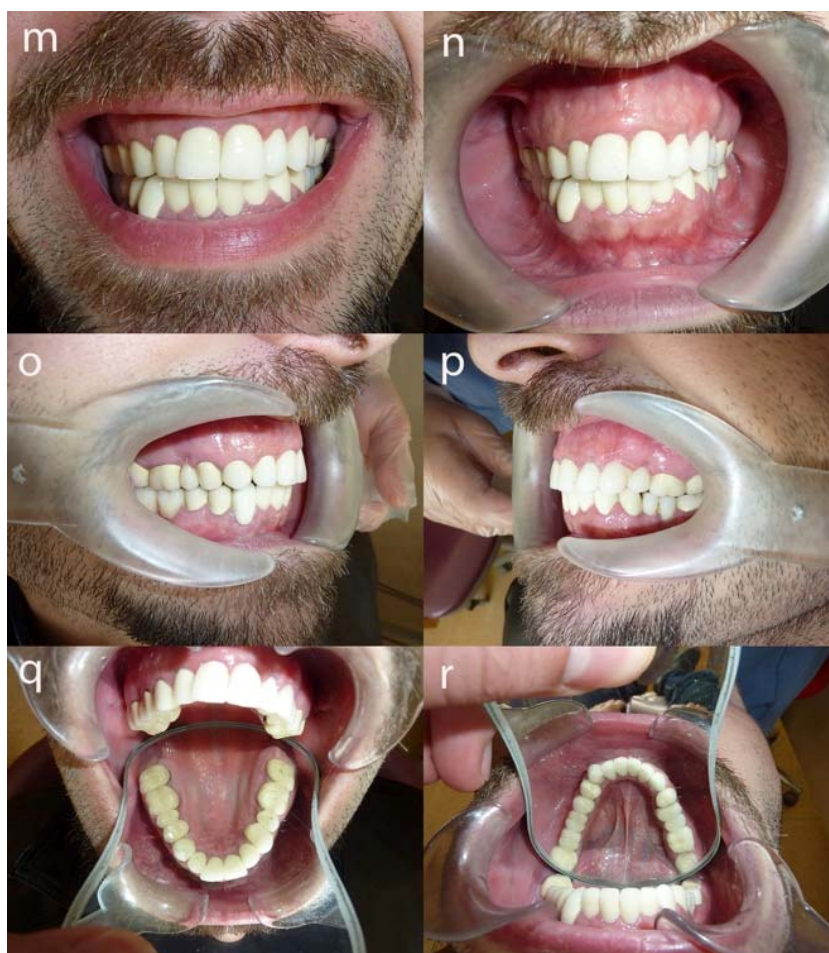


Figure 5. Dental images after 5 years the prosthodontic treatment. (a) 5 years after the patient's aesthetic image. (b) Monitoring the relationship of occlusion and periodontal. (c) The closure of the image from the right. (d) The closure of the image from the left. (e) Follow-up post-the image of the maxillary teeth. (f) Follow-up post-the image of the mandibular teeth.

present a good environment for the bacteria that cause tooth decay (Kitchens and Owens, 2007).

The restoration of tooth wear with many different materials and techniques can be used for patients with dental erosion (Dahl et al., 1993). Restoration of lost tooth structure with increase in the durability of the tooth can be achieved as a result of reduction of stress, with restorative work that occurs in the cervical region to prevent dentin sensitivity causing pulpal damage (Blair et al., 2002; Peutzfeldt et al., 2014). In this case, eroded hard tissue of the teeth was mended with root canal therapy and post-core treatment. With crown and bridge restoration, the chewing efficiency is improved by adjustment of chewing forces (Trushkowsky and Garcia-Godoy, 2014).

Outcome and clinical performance of fixed dental prosthesis (FDP) can be affected many parameters such

as the size and position of teeth, tooth cavity and the used materials (Anusavice, 2012). Tetragonal zirkonyttria stabilizopolycrystal (Y-TZP) materials as a suitable alternative is a molten metal (PFM), because of biocompatibility and positive aesthetic considerations (Filser et al., 2001). In the current patient, long-term and excessive cola consumption induced the erosion of the teeth that are treated conservatively including root canal treatments. In this case, according to the preference of patient and aesthetic considerations, PFM-porcelain system was performed for posterior teeth, Y-TZP-porcelain system was used for anterior part of the mouth. After 5-years follow-up, patient satisfaction was observed with no complaints related to the prosthetic treatment. Obtaining a detailed history, general and dental health of the patient is the most important factor during differential diagnosis of etiology of excessive dental erosion and

caries. We think that improving compliance of patient to the management plan and his adaptation to the lifestyle changes and regular follow-up are the major determinants of long-term success of management of dental erosion related to excessive cola consumption.

Conflict of interest

The author declares that there is no conflict of interest.

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Full Length Research Paper

Evaluation of linear-elastic fracture toughness of the teeth restored with different post and core systems

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The purpose of this *in vitro* study was to investigate the linear-elastic fracture toughness of endodontically treated teeth after restoration with prefabricated post systems against root restored with metal cast post-core. Thirty two maxillary canines with similar anatomic characteristic were sectioned to obtain the same length for all specimens. Group I consisted of 8 roots restored with FibreKor system; Group II consisted of 8 roots restored with C-Post system; Group III consisted of 8 roots restored with metal cast post-core (the diameter was similar FibreKor system); and Group IV consisted of 8 roots restored with metal cast post-core (the diameter was similar C-Post system). Specimens were cemented with dual-cure bonding agent (Dual-Cement and Unibond). These specimens were then mounted in acrylic blocks and tested in a universal testing machine (Kratos). Each sample was angled at 135° to the long axis of the root. A constantly increasing force was applied until the root fracture. Means (kilogram force, kgf) and standard deviations for four groups were found to be: Group I, 31.01 (2.08); Group II, 41.32 (3.44); Group III, 49.17 (2.09); Group IV, 47.65 (2.94). The present research indicated that root restored with metal post was statistically significant ($p < 0.05$), more resistant to fracture over root restored with non metal post.

Key words: C-Post system, linear-elastic fracture, endodontic, teeth.

INTRODUCTION

The restoration of endodontically treated teeth is a complex procedure. Endodontically treated teeth, often resulted into the loss of a significant part of the tooth structure, weakness due to the endodontic treatment (Sedgley and Messe, 1992).

There are many therapeutic methods for the restoration

of these teeth. Often the decision-making confuses the practitioner. The post and core is the method used most frequently. However, this treatment may weaken the remaining tooth structure. A high failure rate has been reported in the literature. Many authors have reported that the vertical fracture is common in teeth restored with

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post and core system. This type of fracture requires the tooth extraction (Pontius and Hutter, 2002; Sirimai et al., 1999). Non-metallic post systems have elastic modulus near the dentin. Martha et al. reports that in this system, the fracture occurs in the cervical region of the tooth. Thus the remaining tooth can be restored (Martha et al., 2008).

It is commonly stated that endodontically treated teeth are more susceptible to fracture as the result of the amount of tooth structure that remains after endodontic treatment. The post space preparation is the other important consideration in the resistance to fracture of pulpless teeth. Metallic post systems generally are used when more than half of the coronal tooth structure is lost (Kimmel, 2000; Barkhordar et al., 1989). Selecting the optimum restorative modality is considered the key to restorative success. Fiber-reinforced composite (FRC) posts were introduced in dentistry, and consist of carbon, glass, or quartz fibers embedded in epoxy resin (Bateman et al., 2003). They have bonding ability to dentin and the core material (Sirimai et al., 1999; Newman et al., 2003). Saupé et al. (1996) reported that FRC posts treated teeth had more resistance to masticatory forces. The modulus of elasticity is similar in all components of the tooth restored (Stricker and Göhring, 2006; Freilich et al., 2000). Therefore, all components are a homogeneous block. According to Dallari and Rovatti (1996), Duret et al. (1996) and Fredriksson et al. (1998), non-metallic post reduces stress in the tooth.

Sidoli et al. (1997) compared the *in vitro* performance and the failure characteristics of the carbon-fiber post system. They concluded that, the specimens restored with the carbon-fiber post system exhibited inferior strength properties to the other post and core system. Dean et al. (1998) observed that there were no differences in fracture resistance among carbon fiber post, tapered stainless steel post, and parallel stainless steel post.

Literature lack consensus as to the best restorative system. The purpose of this study was to determine the null hypothesis of no difference in linear-elastic fracture toughness between non-metallic post system and metal cast post-core.

MATERIALS AND METHODS

Thirty two extracted maxillary canines (selected by the Human Teeth Bank of Universidade de São Paulo – Bauru, School of Dentistry, controlled by the Ethics Committee of the school) were used for this study. The teeth were selected to submit similar dimensions. A digital caliper was used. This device recorded the dimensions vestibule-lingual and mesial-distal to the level of the cervical region of the teeth. Teeth to submit discrepancy greater than one millimeter were discarded.

All teeth were stored in a timol 0.9% saline solution before experimental storage times; prepared specimens were stored in deionised water at 37°C. Teeth were randomly divided into four groups of 8. All teeth were endodontically treated. Crowns were

then resected at the cement enamel junction to achieve the length of 12 mm. The root was mounted in acrylic resin block with 9 mm of the root in the block and 3 mm outside the block.

Group I: Fibrekor post and composite core

The roots were prepared for post placement using the armamentarium supply kit manufacture to develop 8 mm post length. The preparation was cleaned using water spray for 15 s. The post space was then dried using paper points. The walls were conditioned for 15 s using 37% H₃PO₄ gel, and cleaned with water spray for 15 s. The cavity walls was dried using paper points and Unibond dental adhesive was applied in a thin layer and light cured for 30 s. The Fibrekor post was cleaned with alcohol at 96% and silane was applied. Unibond dental adhesive was applied and light polymerized for 30 s. Posts were cemented into the post hole with dual cement and excess cement was removed using hand instruments. Fibrekor was light-cured for 40 s. The remaining dentin surface was acid etched for 15 s and cleaned prior to the application of the Unibond dental adhesive; this was light polymerized for 30 s. The coronal build up was finally completed using a self-polymerizing resin composite (Build-it, Jeneric-Pentron, Inc.) inserted in an adjusted metal matrix. To ensure even distribution of force, a foil metal incisal-lingual bevel was placed in core resin composite.

Group II: C-Post and composite core

The root canal was prepared using drill n°1 or pre-shaping drill following drill n°2 or finishing drill to the preparation depth of 8 mm. The post was a parallel-side stepped post having a coronal diameter 1.5 mm and apical diameter of 1.0 mm. The preparation was conditioned, dried, and dental adhesive was applied, and light cured as in Group I. The carbon fiber post was sandblasted for 2 to 3 s with a micro-etcher and cleaned with water spray for 15 s; C-Pos was then cemented with dual cement and light cured for 40 s. The coronal surface was made as in Group I. To ensure even distribution of force, a foil metal incisal-lingual bevel was cemented in core resin composite.

Group III: Cast post and core with anatomy similar to Fibrekor

The post space preparation was made with Gates Glidden burs n°1 to 4 to a depth of 8 mm and diameter of 1.2 mm at the coronal portion. A direct impression of the root preparation was made with Duralay resin. A matrix partner was used to make the core portion. After custom cast metal post, this was sandblasted for 2 to 3 s with a Micro-etcher and cleaned with water spray for 15 s. The walls of the root were conditioned, dried, and dental adhesive was applied and light cured as in Group I. Post were cemented into the post hole with Dual Cement and light cured for 40 s in buccal, lingual, mesial, and distal faces.

Group IV: Cast post and core with anatomy similar to C-Post

The post space preparation was made with the drill of the Kit of C-Post to that if it got a length of 8 mm. Abundant irrigation was used to guarantee the removal of the debris of the interior of the conduit in all the stages. The impression of the post space was made with pins of the type Pin Jet® and resin Duralay®. A small mark was made with a bur diamond drill on the pin Pin Jet® in a length of 8 mm. Through this mark, it was possible to check the waste of the post space if it correspond to the wanted length and if the pin reached the end of the preparation. The interior of the conduit was

lubricated with solid vaseline through the drill of wide n°2, involved in a cotton wick. A small portion of acrylic resin Duralay® was taken into the post space and distributed with a lentule drill; the pin was introduced until the risk reached the cervical limit of the root. It was waited for 2 min and the pin was removed to avoid the fact that the resin adhered to the walls. After the complete polymerization of the resin, the coronary portion of the pin was sectioned with approximately 3 mm of saliency in relation to the cervical level, so that it roots is possible to position the metallic head office described previously. This head office was lubricated with solid vaseline through a brush. Small portions of acrylic resin were placed at the head office, until it filled out the interior completely. The head office was positioned on the resin pin, being careful to adapt from the best possible way to the limits of the root, mainly in the vestibular face, and after 2 min it was removed, to avoid the resin from sticking to the internal walls. After the complete polymerization of the resin, the pattern was taken for inclusion in coating and subsequent foundry in metallic league CuBe2.

After the foundry of the cast post and core, it was adapted to the root, which remove possible bubbles with drills carbide n° 1701 in high rotation and refrigeration. Kota® liquid-carbon was used when necessary to obtain a better adaptation of the post.

The fixation of the nucleus in the root was accomplished with Dual resinous cement (Cement®). The root was conditioned with acid phosphoric at 37% for 15 s and washed in water for more 15 s. The excesses of water of the interior of the root were removed with cones of absorbent paper. To avoid the complete drying of the walls, a paper cone was applied soaked in water against the walls of the conduit. The sticker of the type Unibond® was applied with a brush, inside the conduit and photopolymerized for 30 s. The melted metallic nucleus air abraded with oxide of aluminum, in the whole surface of the root portion and it was washed in running water by 30 s. A portion of Dual cement (Cement®), was manipulated for 10 s and applied with a brush on the root portion of the nucleus. The nucleus was seated inside the root with movement of it to improve the distribution of the cement in the walls. After the removal of the excesses, the proof body containing the nucleus was positioned under a device developed to maintain a uniform force during the foundation (Illustration 4.5). The polymerization of the dual cement was gotten through the light application by 40 s in the faces vestibular exam, lingual, mesial and distal, and the chemical polymerization happened at least 5 min after agreement with the manufacturer's specifications. To follow the proof bodies, they were stored in a recipient with water deionised and maintained in a greenhouse to 37° for 24 h.

After sample preparation, the specimens were stored in deionised water at 37° for 24 h before being tested. The specimens were kept slightly above the water level. Thus the specimens were preserved in water absorption.

The specimens were then subjected to a load on a universal testing machine (Kratos). Each sample was angled at 135° to the long axis of the root. A constantly increasing force was applied until the root fracture.

The force at failure was analyzed statistically with analysis of variance. The Method of Student-Newman-Keuls was used to evaluate the comparisons in pairs for the four groups of the study.

RESULTS

There were difference in resistance to fracture among the four groups (no statistically significant difference in resistance to fracture among groups III and IV).

The resistance values to the fracture for Group I, roots restored with the system Fibrekor®, was what presented the smallest medium value, 31.01 kg force (kgf), with a

standard deviation of 2.08 kgf. Group II, roots restored with the system C-Post, obtained a medium value of 41.32 kgf and a standard deviation of 3.44 kgf. Group III, roots restored with cast post and core with anatomy similar to Fibrekor, presented a medium value of 49.17 kgf and deviation pattern of 2.09 kgf. Group IV, roots restored with cast post and core with anatomy similar to C-Post, presented a medium value of 47.65 kgf and deviation pattern of 2.94 kgf.

Results revealed that the roots restored with cast post and core presented larger resistance to the fracture, being statistically significant (tests Student-Newman-Keuls), $p < 0.05$ in relation to the Groups I and II.

Table 2 presents the obtained results of the resistance tests to the fracture accomplished in the machine of Universal tests Kratos, for each samples and the average and standard deviation of each group.

DISCUSSION

The Fibrekor systems and C-Post are non-metallic pins. It has been speculated in literature that these pins have elastic modulus similar to tooth structure. This similarity can contribute to the restoration that has better resistance to masticatory forces. However, this is not well established in the literature. Many authors report the advantages of non-metallic pins. But when there is little remaining tooth structure, these pins do not show the alleged performance. Fiberglass pins are superior aesthetics to the metal cast post and core. Thus, this study opted to use the canine, a single-rooted tooth. These teeth can better reproduce the clinical conditions. In Group III, eight superior canine teeth received metal cast post and core. The cast post were made with a length of 8 mm inside the root canal and an approximate diameter of 1.2 mm. The root canal in Groups III and I were prepared with the same anatomy (similar to Fibrekor®). Group III achieved the best results. The average achieved by this group was 49.17 kgf. This value was statistically significant ($p < 0.05$) compared to Groups I (Table 1). Group I had an average of 31.01 kgf. Despite the fact that Groups I and III present similar anatomy, the specimens of Group I showed lower results. In this work, comparing Groups IV and Group II, it showed that Group IV required a force significantly larger (average 47.65 kgf) than the necessary force to fracture the roots of the Group II (average of 41.32 kgf) which is statistically significant.

This study failed to demonstrate the superiority of non-metallic pins. In both situations tested, the cast metal post and core showed better results than the Group I (Fibrekor) and Group II (C-Post). The longevity of the restorative treatment is the main goal. The cosmetic may not be the only factor that determines the choice of a therapeutic method. The durability of a restoration must be established by a number of factors, including the ability to withstand the masticatory forces. The resistance

Table 1. Comparisons among the groups for the Student-Newman-Keuls statistical test for the resistance to the fracture.

Comparison	Differences among averages	P	Q	P<0.05
Cast Post III/Fibrekor	18.16	4	18.99	Yes
Cast Post IV/C-Post	7.85	3	8.21	Yes
Cast Post III/Cast Post IV*	1.52	2	1.59	No
Cast Post IV/Fibrekor	16.63	3	17.40	Yes
Cast Post IV/C-Post	6.32	2	6.61	Yes
C-Post/Fibrekor	10.31	2	10.78	Yes

*The values presented with asterisks did not present statistically significant differences amongst themselves.

Table 2. Individual values, averages and respective deviation-pattern for each experimental condition (values in Kilogram-force, Kgf)

Sample	Group I	Group II	Group III	Group IV
1	31.45	43.35	50.70	48.00
2	32.10	41.90	49.30	45.00
3	32.45	39.55	50.90	50.40
4	30.95	37.70	45.10	44.98
5	34.50	42.40	50.60	47.00
6	30.10	47.70	46.90	51.15
7	28.45	41.35	49.50	51.05
8	28.30	36.80	50.40	43.80
Mean	31.01	41.32	49.17	47.65
Standard deviation	2.08	3.44	2.09	2.94

to fracture is one of the properties that determines this ability to withstand the masticatory forces. The results obtained in this study seemed to be in agreement with the statement of other authors (Sidoli et al., 1997; Morgano and Brackett, 1999; Sirimai et al., 1999); they obtained results similar to the present study, where the metal post demonstrated larger resistance to the fracture of the remaining root. Already Mc Donald et al. (1990) did not find any difference between metal post and carbon fiber post.

Group II, presented larger values when compared with Group I, and it was statistically significant, $P < 0.05$.

The fracture type presented by the specimens was not statistically analyzed in the present study. The four groups presented characteristics similar in relationship to the fracture place, in spite of the fact that Groups I and II obtained larger incidence of fracture of the coronary portion and larger displacement of the nucleus than the other two groups. Many researchers have argued that closer fracture of the cervical level can be important to reutilization of the root. However, if a restorative treatment fails to ease, this treatment may not be beneficial to the patient. Clinical studies have shown that the presence of at least 2 mm remaining tooth structure type core used is not adversely influenced. The use of non-metallic pins should be limited to these clinical situations.

No effort was accomplished to simulate the periodontal ligament, during the inclusion of the roots in the samples, because the incorporation of silicon with this objective seems to be a doubtful procedure due to lack of studies that prove that this material presents the same characteristics of the periodontium (King and Setchell, 1990).

The choice of an appropriate system for the restoration of the remaining dental element is a difficult task due to the great amount of systems found at the market. Several clinical situations observed other factor that prevents the use of a unique system. Clinical studies are necessary to evaluate the behavior of these systems.

Conclusions

Within the parameters of the study design and materials tested, the following conclusions may be made:

1. Group III (cast post and core similar Fibrekor) demonstrated significantly higher resistance to fracture than the other groups;
2. Group II (C-Post), demonstrated more resistance to fracture than Group I (Fibrekor) with statistically significant differences;
3. Group IV (cast post and core similar to C-Post) demonstrated significantly higher resistance to fracture

than Group I;

4. Group I (Fibrekor) demonstrated significantly less resistance than other groups;

5. No statistically significant difference in resistance to fracture was demonstrated between Group III and Group IV.

Conflict of Interest

The authors have not declared any conflict of interest.

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Full Length Research Paper

Post operative pain in endodontics: A systemic review

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Post operative pain is an unpleasant situation for both the dentist and the patient. The purpose of this review is to analyze the effect of certain factors like, gender, teeth type, single/multiple visits, and pre-obturation pain, on the incidence of post endodontic pain. Electronic database were searched in a systematic method according to the preferred reporting items for systematic review and meta analysis guidelines, with specified inclusion criteria to identify randomized clinical trials and exclude case reports and expert case series. Thirty eight articles were identified and included in this review. It was found out that the variables that affect post endodontic pain can be classified into gender, type of teeth, relation with pre-obturation pain, single/multiple visits, medications, instrumentation and obturation techniques and vitality of teeth. The level of evidence ranged from I (1) to V (5) for each variable. The current review suggests that the factors that influenced the post endodontic pain were interrelated and directly interdependent. Within the limitations of this review like insufficient amount of level I, it is evident to support strongly, the influence of the different factors on post endodontic pain. There is a greater need for more number of randomized clinical trials to support the effects.

Key words: Post operative pain, endodontic, clinical trials.

INTRODUCTION

The primary goal of endodontic treatment is to hermetically seal the entire root canal system by an adequate biomechanical preparation, with no discomfort to patient and provide condition of periradicular healing (Udoye and Aguwa, 2010). Even with the outmost care in performing a root canal treatment, some patients experience pain or flare up after treatment. This post operative pain is an unpleasant situation for both the dentist and patient. For the long term success of a case, postoperative pain is considered as a poor indicator. So, the integral part of endodontic treatment must be prevention and management of this post endodontic pain.

According to previous published data reported, frequency of post endodontic pain ranges from 1.4 to 16% and sometimes up to 50% in some studies (Ehrmann et al., 2003; Oliveira, 2010). This difference is due to the difference in definitions of post endodontic pain. A number of factors have been related in different literatures with the incidence of post endodontic pain. Among the factors include, the gender, type of tooth, pre-obturation pain or preoperative pain and post endodontic pain, single/multiple visits, various medications used, instrumentation and obturation techniques and the vitality of the teeth. Although, microorganisms are usually

Table 1. Inclusion and exclusion criteria.

Inclusion
English criteria
Randomized clinical trials that assess the effect of different variables on post endodontic pain
Patient who receive any medications before root canal treatment
Pain intensity and swelling occurrence within 24 to 48 h after root canal treatment
Severity of pain estimated by scales
Cohort studies
Systemic reviews of these studies
Exclusion
Case reports
Expert opinions
Pain and swelling after 48 h
Patient with systemic diseases

regarded as the most common cause of postoperative pain, other causes include mechanical or chemical injury to pulpal or periapical tissues. There is a clear indication of interactions between periapical tissues and microorganisms, because flare-ups are more likely to occur in necrotic cases than in vital cases. This could indicate a clear relationship between pulp status and postoperative pain, even after successful endodontic therapy.

Therefore, the objective of this review is to analyze critically the influence of various factors on the incidence of post endodontic pain and to document the level of evidence available for each factor.

Measurements of pain

Visual analogue scale: It contains a line from 1 to 100, from no pain to worst possible pain. The intensity of post endodontic pain ranges from 5 to 44 points.

Facial Grimace scale: Face 0, very happy (no pain); Face 1, hurts just a little bit; Face 2, hurts a little more; Face 3, hurts even more; Face 4, hurts a whole lot; Face 5, hurts as much as you can imagine.

Generally, the intensity of pain can be measured accurately when more than 1 scale is used.

MATERIALS AND METHODS

This study was registered with the research centre of Riyadh Colleges of Dentistry and Pharmacy and was given a registration number FRP/2015/168.

To obtain the relevant information, a unified criteria was maintained as flare up or post endodontic pain was defined as a complaint of pain with or without swelling within few hours to few

days after root canal procedure. The data base search was undertaken to identify studies that deals with post obturation or post endodontic pain, using PUBmed data, Google, and medical subject headings search. The key headings used for the search strategy were "flare up", "inter-appointment pain", "post obturation pain", "post endodontic pain", "post operative pain", "antibiotics", "analgesics", "instrumentation", "obturation", "vital", "nonvital", "single visits", "multiple visits", "NSAIDs", "gender", and "pre-obturation pain". Only English written articles were identified. For an initial search, 136 articles were obtained. The related articles for the studies were also evaluated. The relevancy of these articles was evaluated by reading their titles and abstracts, from which 44 were rejected as it was not related to the study. The remaining 92 articles were then assessed at the abstract level for their eligibility, out of which 38 were excluded. Out of the remaining 54, full text articles were subjected to inclusion and exclusion criteria (Table 1). Reference lists of these articles were also evaluated. Finally, 38 articles from 1986 to 2014 were included in the quantitative synthesis in this review. These were then subjected to preferred reporting items for systemic review and meta analysis (Figure 1). The level of evidence was set according to the evidence based medicine (Table 2).

RESULTS AND DISCUSSION

From the total of 38 articles found suitable in the inclusion criteria, the articles were broadly classified into different variables or factors affecting post endodontic pain like: gender; type of teeth; relation between preoperative or pre-obturation pain and post endodontic pain; medications; single/multiple visits; instrumentation and obturation techniques; and vital and non-vital teeth.

Gender

Various studies have been done in the past to evaluate the influence of gender on post endodontic pain. Results of studies are summarized in Table 3.

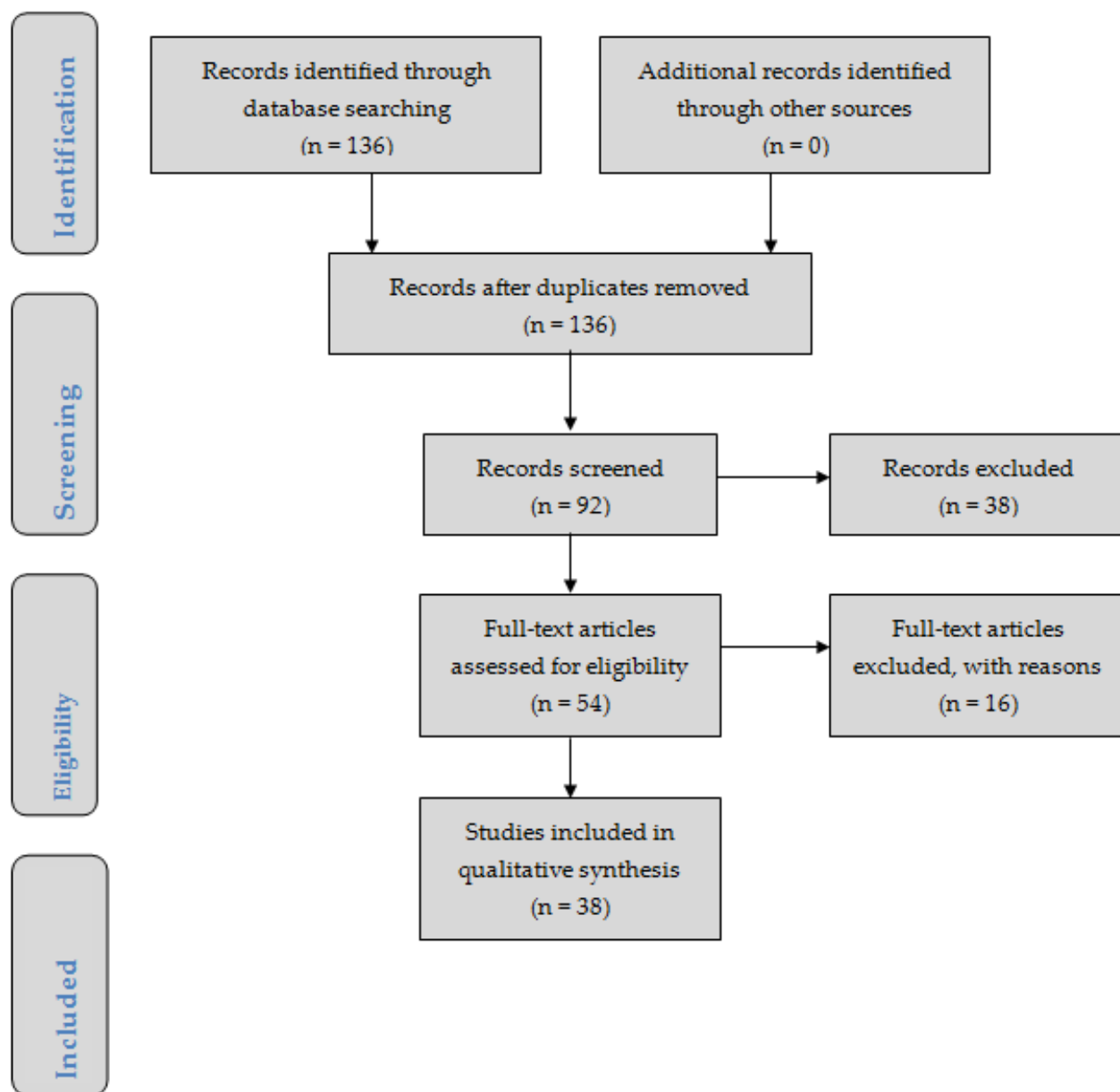


Figure 1. Preferred reporting items for systemic reviews and meta-analysis protocol used in the study.

In general, it can be concluded that women had a higher incidence of post endodontic pain when compared with men. Various studies showed that female patients have more sensitive responses to root canal treatment than male patients. This may be explained by the biological differences between genders, due to the two fluctuating hormone levels associated with change in the level of serotonin and non-adrenalin (Marcus, 1995; Dao et al., 1998). The feeling of pain is regulated by cortisol hormone which is responsible for pain. Normally, its amount excreted in male is higher than in females (Walton and Fouad, 1992; Mehrvarzfar et al., 2008).

Determining whether women have different sensitivity to pain or analgesia compared with men is complicated by the hormonal cyclicity of women. In most clinical research studies, men have been used as subjects and women have been largely excluded (Greenspan and Craft, 2007). This can be justified by the effect of estrogen and the women’s menstrual cycle.

Type of teeth

There have been studies on the incidence of post endodontic pain by the type of teeth treated, whether

anterior, premolar or molar. Results of studies are summarized in Table 4.

In general, it can be concluded that the incidence of post operative pain was higher in mandibular teeth as compared to maxillary teeth. This variation might be due to the reason that mandible has a dense trabeculae pattern, which causes reduced blood flow and localization of infection leading to delayed healing patterns (Syed et al., 2012). This difference may be also explained due to the greater number of canals and complex root canal morphology apically (Watkins et al., 2002; Cleghorn et al., 2006). The length of the treatment could also explain this result, taking into account the progressive decrease of the anaesthetic effect, together with the increase of the anxiety of the patient as the intervention extended (Claffey et al., 2004; Mikessel et al., 2005). In comparison of premolar teeth with anterior teeth, it was found out that theta higher incidence of pain was for premolars due to the higher prevalence of missed canal and variation in the apical canal anatomy.

Preoperative/pre-obturation pain

In the past, several attempts have been made to find whether there exists a correlation between preoperative pain and post endodontic pain. Results of studies are summarized in Table 5.

It can be concluded that there is a strong positive correlation between preoperative and post endodontic pain or post obturation pain. This finding could be explained by the presence of pretreatment infection, which can lead to secondarily infected during treatment (Risso et al., 2008).

Medications

Previous studies have shown that preoperative administration of drugs might have an effect to suppress or reduce post endodontic pain. The search criteria for the drugs yielded 5 results which are represented in Table 6.

Administration of NSAIDs before endodontic therapy can suppress post endodontic pain, before it begins. This can be explained by the action of NSAID to block COX pathway inhibiting prostaglandin synthesis by decreasing the activity of cyclo-oxygenase enzyme and pain sensation is blocked before it begins (Menke et al., 2000).

Single/Multiple visits

There have been several attempts in the past to study a relation between single visit and multiple visit on post

endodontic pain. There were different schools of thought, some states a higher incidence in post endodontic pain following single visit while the other shows high incidence by multiple visits. The results are summarized in Table 7.

In this study, 13 articles were found in the inclusion criteria that talked about the post endodontic pain. There was no significant difference found in the incidence of post endodontic pain in single or multiple visit endodontic treatment. This factor is very controversial and there are many opinions related to the risks of single/multiple visits (Sathorn et al., 2005). The advantages of single visit include, less number of appointments, less stress for an anxious patient, no risk of inter-appointment leakage, no temporary restorations fallings, but on the other hand its disadvantages include bacterial eradication not maximized and compromised healing rate (Spångberg, 2001). Multiple visits advantages include complete eradication of microorganisms; using calcium hydroxide, could reevaluate the tissue responses, and its disadvantages include, prolonged number of visits, inter-appointment flare ups, and patient fatigue. So, this basically depends on the vitality of teeth, use of intracanal medicaments, presence or absence of periapical radiolucency.

Instrumentation and obturation technique

No much study have investigated the patients post endodontic pain experienced after instrumentation with different techniques and by the obturation pattern within our inclusion criteria, we were able to find out only two studies, regarding this. Results of studies are summarized in Table 8.

Post endodontic pain after instrumentation is of great concern to the dentist, as due to the chances of over instrumentation, extrusion of root cleaning and filling materials increase the chances of post treatment pain (Genet et al., 1987). Step down or crown down technique produce term incidence of post endodontic pain when compared with step back technique. This may be due to the reason that step back technique; there is a high chance of pushing the debris beyond the apical foramen as stated in different studies (Ruiz et al., 1987; Al Omari and Dummer, 1995). In the step down technique, the bulk of tissue debris and microorganisms are removed before apical instrumentation is commenced, which greatly reduces the risks of extrusion causing periapical inflammation (Carrotte, 2004).

Vital and non-vital teeth

Wide variations exist in the literature concerning the incidence of post endodontic pain due to the vitality of teeth. The results of our search criteria are summarized

Table 2. Level of evidence according to evidence based medicine.

Explanation	Level of evidence
High quality systematic reviews of randomized controlled trials; Individual randomized controlled trials (with narrow confidence interval)	I
Systematic reviews of cohort studies; Individual cohort study or low quality randomized controlled trials	II
Systematic review of case-control studies; Individual case-control study, retrospective comparative study	III
Case-series	IV
Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	V

Table 3. Studies on the influence of Gender on post endodontic pain.

Author	Sample	Conclusion	Level of evidence
Al Negrish and Habahbeh (2006)	120	Incidence of post endodontic pain in females (6%), males (3%)	III
Al bashaireh and Al Negrish (1998)	300	Incidence of post endodontic pain in females (5.2%), males (3.9%)	II
Sayeed et al. (2008)	1328	Higher incidence in females (7.4%), than males (1.8%)	I
Salma and Khurshiduzzaman (2013)	60	Incidence of post endodontic pain in females (10%), males (6.7%)	II
Talha et al. (2011)	60	Incidence of post endodontic pain in females was more than males	II

Table 4. Studies on the influence of type of teeth on post endodontic pain.

Author	Sample	Conclusion	Level of evidence
Najma et al. (2014)	60	Pain experienced in mandibular teeth were more than maxillary teeth	III
Castellanos-Cosano et al. (2012)	80	Post endodontic pain was significantly higher in molar teeth RCT	II
Salma and Khurshiduzzaman (2013)	60	More pain in premolar teeth when compared to anterior teeth	II
Segura-Egea et al. (2009)	176	Mandibular teeth had higher incidence of pain (42%) than when compared with maxillary teeth (26%)	III

Table 5. Studies on the influence of preoperative/obturation pain on post endodontic pain.

Author	Sample	Conclusion	Level of evidence
Sayeed et al. (2008)	1328	Patients with preoperative pain had more post operative pain (10.5%) when compared to patients without pain	I
Ng et al. (2004)	415	Preoperative pain had influence on post endodontic pain	III
Genet et al. (1987)	229	Higher incidence of post endodontic pain after 24 h with preoperative pain	III
Durre and Muhammad (2014)	140	Patients with preoperative pain had more (83.3%) post operative pain	III
Genet et al. (1986)	1204	Strong co-relation between preoperative and post operative pain (65%)	III

Table 6. Studies on the influence of medications on post endodontic pain.

Author	Sample	Conclusion	Level of evidence
Al-Kahtani (2014)	40	Long acting anesthetic like bupivacaine can cause less post operative pain than lidocaine	I
Sayeed et al. (2008)	39	Single dose of pretreatment analgesic did not reduce post endodontic pain	I
Priyank et al. (2014)	30	Single dose of 10mg ketorolac and 100mg tapentadol as pretreatment analgesic reduced the post endodontic pain	I
Hakan et al. (2011)	48	A prophylactic single dose of 20 mg tenoxicam significantly reduced the post operative pain	I
Jalalzadeh et al. (2010)	40	Single dose of prednisolone preoperatively substantially reduced the post endodontic pain	I

Table 7. Studies on the influence of single/multiple visits on post endodontic pain.

Author	Sample	Conclusion	Level of evidence
Wang et al. (2010)	100	No difference in pain levels between single and multiple visits	III
Singh and Garg (2012).	200	No difference in post operative pain between single/multiple visits	I
Prashanth et al. (2011)	32	No difference in post operative pain between single/multiple visits	III
Sumita et al. (2012)	80	Within 48 h pain for multiple visits were more	III
Krishna et al. (2013)	400	No difference in post operative pain between single/multiple visits in 48 h	III
Kavita et al. (2013)	60	No difference in post operative pain between single/multiple visits within 48 h	III
Raju et al. (2014)	110	Incidence of postoperative pain does not seem to be a valid comparison between single/multiple visits	III
Jorge et al. (2000)	150	Meticulously Instrumented One visit RCT can be as successful as two visit	I
DiRenzo et al. (2002)	72	No difference in post operative pain between single/multiple visits	II
Mulhern et al. (1982)	60	No significant difference in incidence of post operative pain between single/multiple visits	II
Rao et al. (2014)	140	No difference in post operative pain between single/multiple visits	III

Table 8. Studies on the influence of instrumentation and obturation on post endodontic pain.

Author	Sample	Conclusion	Level of evidence
Salem et al. (2009)	115	Step down technique had less post operative pain than step back technique	II
Luis-o et al. (2012)	204	Thermafil obturation produced higher incidence of pain	III

in Table 9.

Evidence of literature of the effect of vitality of the pulp on incidence of post endodontic pain

remains inconclusive. The progression of pain in vital pulp might be due to the injury of periapical tissues during endodontic treatment which in turn

increases the amount of prostaglandins, serotonin, histamines and bradykinin secretion (Mehrvarzfar et al., 2008). The higher incidence

Table 9. Studies on the influence of vitality of teeth on post endodontic pain.

Author	Sample	Conclusion	Level of evidence
Gotler et al. (2012)	85	Teeth with vital pulp had higher incidence of post endodontic pain than necrotic pulp	II
Oginni and Udoye (2004)	255	No relation between vitality and post operative pain	III
Farzana et al. (2010)	5	Pulp whether vital or non-vital had little effect on post endodontic pain	II
Bhagwat and Mehta (2013)	60	No significant difference between vital and non-vital teeth	II
Oginni and Udoye (2004)	60	No significant difference between vital and non-vital teeth	II
Bayram et al. (2009)	306	No significant difference between vital and non-vital teeth ($p>.01$)	II

of pain in non-vital pulp may be due to the presence of more microorganisms in the complex anatomy of the apical third canal and the presence of periapical bone destruction area (Ng et al., 2004).

Conclusion

The rate of post operative pain after endodontic treatment ranges from 1.4 to 1.6%. The occurrence of mild to moderate type of pain can occur even after rendering treatment of the highest standards. Its case as found from this systemic review is poli-etiological. All the factors are interrelated and directly, interdependent. Most importantly time is an important factor to consider in post endodontic pain. As evaluated and stated by different studies, minimal to moderate type of pain normally subsides with time. So, the dentist should not be over anxious or over react to an incidence of post endodontic pain and immediately initiate with retreatment or extraction.

Conflict of interest

Author has none to declare.

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