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Coronal tissue loss in endodontically treated teeth

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Abstract
Aim: To categorize the endodontically treated teeth according to the extent of coronal tissue loss in order to determine the appropriate restoration required.
Material and methods: A two year descriptive study was done at the Conservative Clinic of the Department of Restorative Dentistry, Dental Centre, University College Hospital, Ibadan. Successful endodontically treated teeth were assessed and categorized according to the extent of tissue loss based on standard criteria proposed by Smith and Schuman.
Results: Two hundred and ninety endodontically treated teeth were assessed for success both clinically and radiographically. Eighty (27.6%) were anterior teeth, 78 (26.9%) were premolars while 132 (45.5%) were molars. Dental caries was found to be the most common (61.4%) indication for endodontic treatment and caused more coronal tissue damage (moderate and significant) when compared with other indications for endodontic treatment. Two hundred and twenty seven (78.3%) endodontically treated teeth had moderate coronal tissue loss, 41 (14.1%) had minimal damage while 22 (7.6%) had significant tissue damage. Dental caries was the most common indication for endodontic treatment of the posterior teeth while trauma was the most common indication for the anterior teeth.
Conclusion: Majority of the endodontically treated teeth that were evaluated for tissue loss had moderate coronal tissue damage. It is therefore recommended that proper and prompt evaluation of the remaining coronal tooth tissue following successful endodontic treatment be carried out in order to determine the appropriate definitive restoration required that will be easy for the clinician and less expensive to the patients.

Keywords: *Spectrum, endodontics, tissue loss, categorization*

Résumé
Objectif: Catégoriser le traitement des dents de façon endodontique selon l'importance de la perte de tissu coronaire afin de déterminer la restauration appropriée requise.
Méthodes: Une étude descriptive de deux ans a été effectué à la 'Conservative Clinic' du Département de la Dentisterie Restauratrice, Centre de soins dentaire, Centre Hospitalier d'Ibadan. Les dents traités avec succès de façon endodontique ont été évaluées et catégorisées selon l'importance de la perte de tissu sur la base de critère standard proposé par Smith et Schuman.
Résultats: Deux cent quatre-vingt-dix dents traitées de façon endodontique ont été évalué pour déterminer la réussite de façon clinique de même que radiographique. Quatre-vingts (27,6%) étaient des dents antérieures, 78 (26,9%) étaient des prémolaires tandis que 132 (45,5%) étaient des molaires. Les caries dentaires se sont révélées comme étant l'indication la plus commune (61,4%) du traitement endodontique et provoquant plus de lésions du tissu coronaire (modéré et important) en comparaison aux autres indications de traitement endodontique. Deux cent vingt sept (78,3%) dents traitées de façon endodontique avaient une perte de tissu coronaire modéré, 41 (14,1%) avaient des lésions minimales tandis que 22 (7,6%) avaient des lésions importantes du tissu. La carie dentaire était l'indication la plus commune dans le traitement endodontique pour les dents postérieures tandis que le traumatisme s'avérait l'indication la plus commune pour les dents antérieures.
Conclusion: La majorité des dents traitées de façon endodontique qui ont été examinées pour les pertes de tissu avait des tissus coronaires modérés. Par conséquent, il faut une évaluation appropriée et prompte du tissue dentaire coronaire restant à la suite d'un traitement endodontique réussi afin de déterminer la restauration définitive appropriée requise qui va être facile pour le clinicien et moins cher pour les malades.

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Introduction

Endodontic treatment involves precautions taken to maintain the health of the vital pulp in a tooth or treatment of a damaged or necrotic pulp in order to allow the tooth to remain functional in the dental arch [1]. Advances in endodontic therapy have revealed that the strength of an endodontically treated tooth is directly related to the amount of the remaining tooth dentine following endodontic therapy [2-4]. It is known that the failure rate of restored root-filled teeth can be higher than for vital teeth [5]. It is believed that removal of pulp from a tooth changes the physical properties of the tooth structure with reduction in

moisture content of dentine leading to a slight increase in modulus of elasticity [6,7] which makes the tooth brittle and necessitates special care during restoration.

Some authors [8,9] have classified or proposed criteria for classification of coronal tissue loss for endodontically treated teeth. For standardization, Halpern [8] proposed a conservative guide for evaluating the existing condition of a root filled tooth and some restorative options were recommended. Smith and Schuman [9] later proposed a more comprehensive guide with more specific restorative options. Coronal tissue damage of the root filled anterior and posterior teeth were classified into minimal, moderate and significant tissue loss using reliable, easy and simple criteria. Since the pattern of coronal tissue loss of some endodontically treated teeth might not fit the template well, the authors suggested that such teeth should be classified as the next more aggressive pattern of coronal tooth tissue damage. Thus a moderate to significant case is classified as being significant.

The amount of remaining tooth structure is a primary determinant in designing a restoration for endodontically treated tooth. Hock was said to have demonstrated by Sivers and Johnson [10] that the strength of an endodontically treated tooth is directly related to the bulk of the remaining dentine. Reeh *et al* [11] likewise suggested that the loss of tooth structure and the destruction of the marginal ridges are the key determinants in the weakening of the tooth.

Following a successful endodontic treatment, the evaluation of coronal tissue loss of the treated teeth is a necessary step to be considered before definitive restoration could be provided [2-4]. It is therefore necessary to conserve the natural crown as much as possible. Unfortunately, this possibility is doubtful as many of the teeth would have been mutilated by caries, trauma, previous extensive restorations and endodontic access openings.

The most important consideration in restoration of the endodontically treated tooth is the amount of damage to the tooth structure [8,10], a development in which the clinician has the least control over and this varies greatly. The lost tissue may be only a minimal endodontic access preparation in an otherwise intact tooth. However, it may also be a significant tissue loss that endangers the longevity of the tooth. The choice of appropriate restorative materials and techniques of restoration is dictated by the amount of remaining tooth structure [8,10].

Many of the endodontically treated teeth often get extracted as a result of endodontic failure [8]. This is largely due to fracture of the root filled teeth which have been weakened by endodontic access apart from the initial effects of caries, fracture or heavy restorations. Despite the importance of the remaining coronal tissue in determination of the success of endodontically treated teeth, there is no report on the categorization of endodontically treated teeth in our environment. The aim of this study was therefore, to categorize the endodontically treated teeth according to the extent of coronal tissue loss with a view to determine the appropriate definitive restoration required for each.

Materials and methods

The study was conducted at the Conservative Clinic of the Department of Restorative Dentistry, Dental Centre, University College Hospital, Ibadan, Nigeria between January, 2006 and December, 2008.The study population comprised of subjects who had successful endodontic treatment within a period of two years spanning January 2006 to December 2007. These patients were allocated to the different treatment groups according to the criteria proposed by Smith and Schuman [9] on tooth tissue loss (Table 1).

The target population comprised of patients who had endodontic treatment done at the study centre between January 2006 and December 2007. Inclusion criteria comprised of patients age range of 18-70 years whose tooth or teeth have had successful endodontic treatment and the oral hygiene was good. Also, patients who had controlled underlying systemic disease and were willing to participate were included.

A prepared data collection form was used during the examination. The form contained demographic and clinical data and also the scoring template for coronal tissue loss. A single examiner (the 1st author) administered this data collection form.

Patients were seated on a dental chair and evaluation of the teeth was done by a single examiner (the 1st author) observing appropriate infection control protocol using primary barrier method with adequate use of disposable materials. For patients who had more than one endodontically treated tooth, data for each tooth were recorded separately. Endodontically treated teeth were assessed for clinical and radiographic evidence of success. Evaluation of root filled teeth for coronal tissue loss was done using the criteria proposed by Smith and Schuman [9].

Ethical Clearance was obtained from the University of Ibadan/University College Hospital Health Research Ethics Committee (UI/UCH HREC). All patients were duly informed of all the procedures and informed consent form signed by all patients who agreed to participate.

Data entry and analysis was done using the SPSS® Statistical Software for Windows, version 11.0 (SPSS Inc. Chicago, IL). Results were presented using tables, figures, charts and plates. Strength of association between qualitative variables was tested using McNemer chi-square test. Tests of significance was set at P-value <0.05

Results

Two hundred and ninety patients were involved in this study. The age ranged from 18-70 years with the mean age being 36.43 ±14.0 years. One hundred and sixty four (56.5%) patients were in the 3rd and 4th decades of life. One hundred and thirty three (45.9%) males and 157 (54.1%) females had their teeth evaluated (Figure 1).

Two hundred and ninety root filled teeth were evaluated for coronal tissue damage. Anterior teeth constituted (80, 27.6%) of the total number while (78, 26.9%) were premolars. Molars (132, 45.5%) were the predominant teeth treated endodontically and both molars and the premolars constituted the posterior teeth Table 2.

From the evaluated 290 teeth, 41(14.1%) had minimal coronal tissue damage, 227(78.3%) had moderate damage while 22(7.6%) had significant tissue damage. (Figure 2).

Out of forty one teeth that had minimal coronal tissue damage, 33 (80.5%) were anterior followed by the molars (12.2%) and the premolars (7.3%). Furthermore, from 227 teeth that had moderate coronal tissue damage, 125 (55.0%) were molars, 27.8% were premolars and 17.2% were

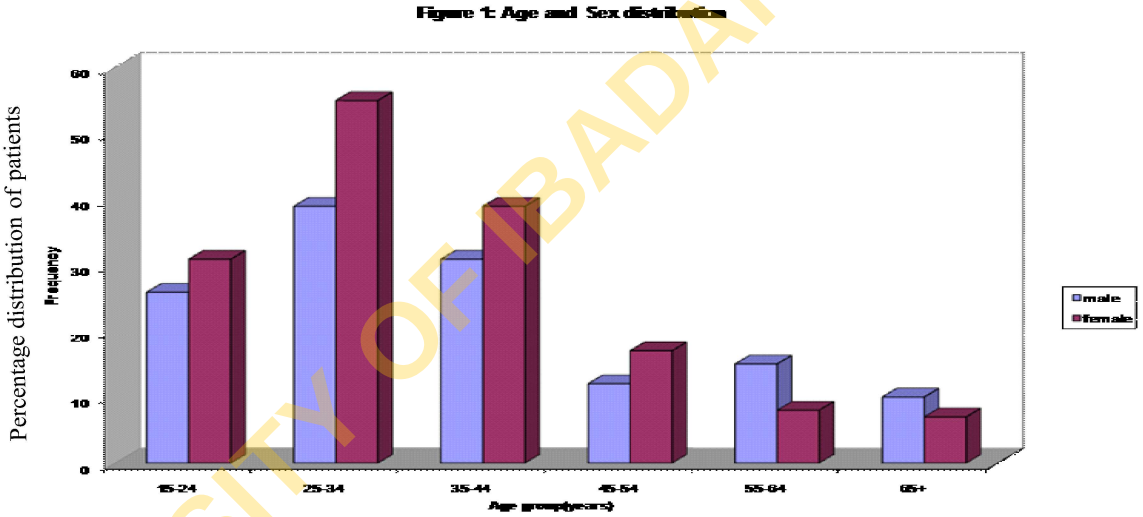

Fig. 1: Percentage age and sex distribution of patients with root filled teeth

Table. 1: Classification of coronal tissue loss on endodontically treated anterior teeth (Adapted from Smith and Schuman's Criteria)

Minimal coronal tissue damage	Moderate coronal tissue damage	Significant coronal tissue damage
A conservative access opening	A conservative access opening	Access opening
Intact marginal ridges	One or two small proximal lesions	Undermined marginal ridges
Intact cingulum	Average tooth size	Loss of incisal edge
Acceptable esthetics		Unacceptable esthetics
Posterior teeth		
A conservative access opening	An access opening	An access opening
Low risk of fracture	Minimum of one sound cusp	Little or no remaining coronal tooth structure
Intact buccal and lingual cusps	Extreme root curvature	High risk of being fractured
Minimal occlusal Forces		To serve as a fixed partial denture or removable partial denture abutment

Table 2: Percentage Distribution of Root Filled Teeth

Root Filled Teeth	Frequency	Percentage (%)
Anterior	80	27.6
Premolar	78	26.9
olar	132	45.5
Total	290	100.0

Dental caries being the major indication for endodontic treatment; out of the affected teeth, 92.7% had moderate coronal tissue damage while 1.7% and 5.6% had minimal and significant tissue loss respectively. For those teeth with trauma as the cause of their endodontic treatment, 44.6% had minimal tissue loss while 46.4% had moderate coronal tissue damage. Out of the teeth that received endodontic treatment as a result of failed restoration, 92.6% had moderate tissue loss while 7.4% had significant tissue loss.

Figure 2: Evaluation of Coronal tooth tissue damage of root filled teeth

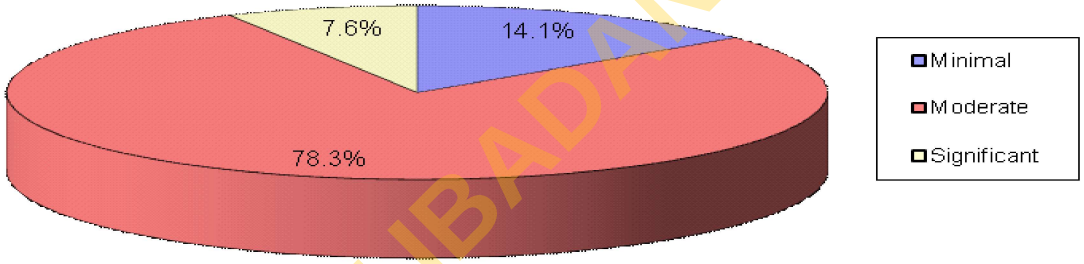

Table 3: Distribution of coronal tissue damage in anterior and posterior teeth

Root Filled Teeth		Coronal tissue damage n (%) Minimal	Moderate	Significant
Anterior		33(80.5)	39(17.2)	8(36.4)
Premolar	Posterior	3(7.3)	63(27.8)	12(54.5)
Molar		5(12.2)	125(55.0)	2(9.1)
		41 14.14	227 78.28	227.59

p = 0.000 (X^2 = 84.239), n = number of teeth

anterior teeth and the difference observed in the type of coronal tissue damage was found to be statistically significant. (p=0.000); with molars and premolars constituting the posterior teeth. Twenty two teeth had significant tissue damage out of which 12 (54.5%) were the premolars, 36.4% were the anterior and 9.1% were the molars.(Table 3).

Perio-endo lesion which is another indication for endodontic treatment was responsible for 81.8% minimal tissue loss while moderate and significant tissue loss constituted 9.1% individually.

In the group of those teeth that were treated endodontically as a result of failed endodontic

Fig 3: Clinical photographs and periapical radiograph of minimal and significant tissue damage involving upper anterior teeth

(a) Clinical photograph showing discoloured 11 and 12 with significant tissue damage of 11 and discoloured minimal tissue damage of 12

(b) Periapical radiography of root filled 11 and 12 with significant tissue damage of 11 and minimal tissue damage of 12

(c) Clinical photograph showing porcelain fused with metal crown on 11 and a bleached 12 restored with composite

treatment, 55.6% had moderate coronal tissue damage while 33.3% and 11.1% had minimal and significant tissue loss respectively. Tooth wear lesion which is another indication for endodontic treatment accounted for 55.6% moderate coronal tissue loss while 33.3% and 11.1% had significant and minimal tissue loss respectively (Table 4).

Discussion

The strength of an endodontically treated tooth depends on the amount of the remaining coronal tooth tissue following successful endodontic treatment [4,7,8-10,12-14]. In addition to this, other factors such as post materials and designs, cement and core materials have been reported to provide retention and support for the artificial crown [15].

Current concept on the restoration of endodontically treated teeth emphasizes the need for the preservation of tooth structure as much as possible

Table 4: Distribution of coronal tissue damage against indications for endodontic therapy

Indications for Endodontic Therapy	Coronal tissue damage n(%)			
	Minimal	Moderate	Significant	Total
Caries	3(1.7)	165(92.7)	10(5.6)	178
Trauma	25(44.6)	26(46.4)	5(8.9)	56
Failed Restoration	0(0.0)	25(92.6)	2(7.4)	27
Failed Endo	3(33.3)	5(55.6)	1(11.1)	9
Tooth Wear	1(11.1)	5(55.6)	3(33.3)	9
Perio- Endo	9(81.8)	1(9.1)	1(9.1)	11
	41(14.1)	227(78.3)	22(7.6)	290(100%)

n= number of teeth

such that the restorative designs are based on the remaining tooth structure [4,8-10,12-14]. Based on the current principles, some authors [7,8-10] have presented restorative guide for decision making that will result in predictable outcome of the restorations. The guidelines have been applied in this study to determine the extent of coronal tissue loss of root filled teeth. Several in vitro and clinical studies [16-21] have been conducted to support the advantages of the current restorative methods over the traditional approach.

The higher percentage of dental caries as an indication for endodontic treatment is in agreement with the previous studies [22-24] among Nigerians and a Jordanian subpopulation in which dental caries was the leading cause of endodontic treatment.

Endodontic treatment is indicated in teeth with diseased pulp which could be caused by dental caries, trauma, tooth wear, periodontal diseases, operatory dental procedures and dental restorative materials [25,26]. In this study, the commonest cause of pulp pathology leading to endodontic treatment was dental caries (61.4%). This is in agreement with its description as being the most common form of injury that causes pulpitis [26,27]. Although there had been report of decline in caries incidence [28] when compared with the previous survey data [29], the disease still constitutes a public health problem as a result of low treatment ratio among Nigerians [28]. From the posterior teeth that were endodontically treated, (34.3%) of the root filled premolars and molars (60.7%) had endodontic treatment as a result of caries involving the pulp, this is due to stagnation areas like deep pits and fissures and the proximal surfaces which make caries prevalence to be much higher in premolars and molars than incisors and canine [30].

Observation in this study that trauma was the commonest (66.3%) indication for endodontic treatment of the anterior teeth agrees with finding in the study done by Akpata *et al* [31]. This is due to their location in the mouth which makes them to be more prone to injury than the posterior teeth [32,33].

Results from this study indicated that majority (78.3%) of the endodontically treated teeth had moderate coronal tissue damage, while only 14.1% had minimal coronal tissue damage. This finding is in contrast with the previous study [34] in which 43.2% of the endodontically treated teeth had minimal coronal tissue damage. The reason for this difference could be as a result of delayed patients' presentation to the clinic which may be due to less awareness of the available facilities for appropriate treatment and poor economy to meet up with the cost of treatment.

Trauma was responsible for most minimal coronal tissue damage while failed restoration as an indication for endodontic treatment had a high number of teeth having moderate coronal tissue loss than it caused minimal or significant tissue damage. This could be as a result of the amount of tissue loss that might have occurred during previous treatment session. Few (3.8%) teeth were root filled as a result of perio-endo lesion in this study. This is because advanced periodontal disease as a component of the perio-endo lesion have hopeless prognosis to periodontal treatment [35,36]. Such teeth were indicated for extraction instead of endodontic treatment. This is because the cost of the treatment is very expensive and the success rate is low.

Majority of teeth (55.0%) with moderate tissue loss after endodontic treatment were molars followed by the premolars and then the anterior teeth. This pattern could be explained by the location of the teeth and the pattern of caries attack on them since the posterior teeth are known to be more prone to caries than the anterior teeth [30]. The delayed presentation of the patients to the clinic with larger carious cavities could also be responsible. The endodontically treated teeth with the highest proportion (80.5%) of minimal coronal tissue damage were the anterior teeth. This was because most of the teeth had intact coronal tooth structure but with necrotic pulp tissue leading to endodontic treatment. Likewise, trauma which was the major cause of indication for endodontic treatment involving the anterior teeth in this study caused minimal tissue damage. More (54.5%) of the significant tissue loss occurred in the premolar teeth than it occurred in the anterior teeth (36.4%) and molars (9.1%). This could be due to the coronal morphology and location of the premolar teeth and the effect of caries on them.

Majority of the endodontically treated anterior and posterior teeth evaluated for coronal tissue damage in this study had moderate coronal tissue loss. Evaluation of the coronal tissue damage is therefore a necessity before the provision of definitive restoration after successful endodontic treatment.

It is recommended that: proper and prompt evaluation of the remaining coronal tooth tissue following successful endodontic is necessary so as to be able to provide appropriate restoration that will be easy for the clinician and less expensive to the patients. More public enlightment campaign should be continuously organized for the better awareness of the prevention of the major cause of endodontic treatment; dental caries so that early intervention in the form of direct restoration could be sufficiently

placed on them. This will reduce the number of tooth loss in patients that could not afford the relative exorbitant endodontic treatment and its eventual definitive restoration in our environment.

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