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Evaluation of reasons for extraction of crowned teeth: A prospective study at a university clinic

IDIL DIKBAS[1], JALE TANALP[2], CEYDA OZCAKIR TOMRUK[3] & TEMEL KOKSAL[1]

[1]*Department of Prosthodontics,* [2]*Department of Endodontics, and* [3]*Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Yeditepe University, Istanbul, Turkey*

Abstract

Objective. The aim of this study was to determine and classify the major reasons for extraction of teeth with full crowns belonging to patients admitted to a university clinic within a specific time frame. ***Methods.*** Two hundred and eight extracted teeth with full crown belonging to 75 patients were included. Apart from demographic information, reasons for presenting to the hospital, the major reason for extraction, the type of the crown (single crown, bridge abutment, abutment for removable prosthesis), presence of posts, age of restorations, presence of an endodontic treatment and quality were recorded. Comparable data were statistically analyzed using the chi-square test. ***Results.*** Forty-three (57.3%) of the patients were females, whereas 32 (42.7%) were males with an average age of 63.21 ± 13.56. A statistically significant relationship was determined between age groups and rate of extractions, with the lowest extractions detected in the 35–44 years age group and the highest in the 55–64 years age group ($p = 0.001$). Tooth mobility was the predominant reason for patients' initial presentation (52.9%). The most encountered reason for extraction was periodontal reasons with a prevalence of 59.1%, followed by caries (26.9%) and periapical lesions (12%); 35.6% of extracted teeth had endodontic treatment. Sixty teeth (81.1%) had incomplete root fillings. There was a significant relationship between extractions and incomplete root fillings ($p = 0.001$). ***Conclusion.*** Studies comprising other faculty clinics as well as general practices will be complementary in making more generalized statements regarding the etiology of extractions of crowned teeth.

Key Words: *reasons for extraction, crowned teeth, tooth mortality, survival, abutment teeth*

Introduction

In spite of preventive measures, advancements in therapeutic aspects of dentistry and attempts of dental practitioners to preserve dentition, extraction is still one of the treatment alternatives in clinical practice depending on a variety of reasons [1]. Tooth extraction, although showing a decrease recently owing to improvements in therapeutic measures of dentistry, is definitely an undesirable consequence leading to loss of function and esthetics. Furthermore; compensation of the lost dentition poses a significant economic burden for the individual, be it performed using removable or fixed dentures or implant placement.

For years, there have been many quests searching for the reasons of tooth extraction. It has been emphasized that understanding the patterns and reasons of tooth extraction in different populations is specifically important for planning of dental health services [2]. Investigations on this topic have revealed that reasons for tooth extraction are caries, periodontal disease, orthodontic treatment, traumatic injuries, prosthetic indications and tooth impaction [3]. Studies have also shown that dental caries and periodontal diseases predominate among the rest. Among 24 articles published from 1980–1999, 20 have reported caries as the main reason for extraction [4]. In general, dental caries has been reported as the main cause of tooth loss in the young, whereas, after 40 years of age, periodontal diseases become more prevalent [5]. Although it has been indicated in some studies that caries-related extractions outnumber those for periodontal reasons in adults, the latter have been shown to play a major role for prosthetic-related extractions in the elderly [2,6–9].

Understanding reasons for tooth extraction is important for health planning purposes and

Correspondence: Associate Professor Dr Jale Tanalp, PhD, Yeditepe University, Faculty of Dentistry, Department of Endodontics, Bagdat Caddesi 238 Göztepe, Istanbul, Turkey. Tel: +0090 216 36360 44. Fax: +0090 216 363 62 11. E-mail: jale.tanalp@yeditepe.edu.tr

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maintenance of acceptable life quality of individuals. Although there have been a considerable number of studies evaluating the reasons and prevalence of tooth extraction, reasons of extraction of crowned teeth or teeth serving as bridge abutments have not yet been evaluated specifically. There are studies, though, that evaluate failure characteristics of crown restorations such as problems with esthetic match and surface texture, marginal discoloration and integrity [10].

Extraction of crowned teeth is an important issue since it not only results in functional and esthetic loss of the individual, but imposes a significant economic load on the patient, specifically if the extraction had to be undertaken shortly after the previous prosthetic treatment had been completed. Extraction may sometimes occur for a tooth in a key position, necessitating completely different prosthetic planning. It may, in some cases, result in the conversion of a fixed prosthesis system into a removable one, which might have functional and psychological impacts on the patient.

Tooth extraction, irrespective of the reason, is an undesirable consequence for a patient and, if the major reasons leading to dental losses are clearly understood, precautions can be taken more meticulously prior to prosthetic planning so that the possibility of an untimely extraction is reduced. A survey of the literature reveals numerous studies aiming to determine the major reasons for tooth extraction; however, there is limited information that focuses specifically on extraction of crowned teeth. The purpose of the present study was to draw a general outline regarding the reasons of extraction of crowned teeth in a patient group admitted to a dental faculty specialty clinic during a specific time frame.

Materials and methods

This study was performed by collecting prospective data from extracted teeth with a full crown belonging to 75 patients who visited the specialty clinics of Yeditepe University, Faculty of Dentistry between June 10 and October 10, 2011. Two hundred and eight extracted crowned teeth were included in the study for evaluation. Prior to the study, confidentiality of the participants were confirmed. Information was collected from those patients who were referred to the Oral and Maxillofacial Surgery Department for extraction of teeth with crowns or bridges. Extractions were carried out by one specialist operator and the procedure was performed following the removal of related crowns or bridges and detailed consultation of specialists from different disciplines. This consultation was made depending on both clinical and radiographic examinations. Radiographic interpretations were carried out both on panoramic and periapical x-ray films where necessary.

Initially, the patient's age and gender were recorded. Other information such as the presence of systemic diseases (diabetes, etc.), specific medical conditions (radiotherapy, etc.) and smoking habits were also noted. The type of the extracted tooth and the related jaw were also recorded. As the teeth included in the study all had crowns, they were classified either as a single crown or a bridge abutment. Additional information was noted in case these crowned teeth also served as abutments for removable partial dentures. The ages of the crown restorations was also among information collected during the study. This was further classified into four groups such as 0–5 years, 6–10 years, 10–15 years and 15–20 years. In case the extracted teeth contained intra-radicular posts, this was recorded, including the type (standard or cast) as well as its condition (satisfactory, unsatisfactory). The marginal qualities of the crowns were also noted. The marginal adaptation of the restorations was scored according to the modified United States Public Health Service (USPHS) criteria [11,12]. According to the criteria, marginal adaptation quality of restorations is scored as follows: Alpha: restoration is continuous with existing anatomic form, explorer does not catch; Bravo: explorer catches, no crevice is visible into which explorer will penetrate; and Charlie: Crevice at margin, dentin exposed.

The presence of a previous endodontic treatment was recorded including the quality of endodontic treatment determined by an endodontics specialist of the faculty. The criterion used to evaluate the quality of root canal filling was as follows: Adequate: maximum 2 mm short from the radiographic apex; Inadequate: more than 2 mm short of the radiographic apex; and Overfill: extending more than 2 mm beyond the radiographic apex.

The motivation of the patients to present to the clinic was other information collected. This included pain, mobility, esthetics, trauma or other reasons which included a problem related with another tooth, periodontal problems, sinus tracts, general dental check-up or prosthetic purposes.

Finally, the reasons for extraction were recorded. These were classified as extensive periapical or periodontal reasons and mobility, extensive and irreparable caries or defects, prosthetic reasons, root resorptions, perforations, root fractures, esthetics, etc.

Statistical analysis

Data were evaluated using the SPSS (Statistical Package for Social Sciences) program for Windows 15.0. Apart from descriptive statistical methods (mean, standard deviation, frequency), chi-square test was used during the comparison of qualitative data. Significance level was set at $p < 0.05$.

Table I. Demographic characteristics of the study population.

		Extracted teeth		
		n	%	*p*
Gender	Female	115	55.3	0.127
	Male	93	44.7	
Age	35–44	12	5.8	0.001**
	45–54	46	22.1	
	55–64	61	29.3	
	65–74	35	16.8	
	75 and above	54	26.0	
Diabetes	Yes	40	19.2	0.001**
	No	168	80.8	
Smoking	Yes	58	27.9	0.001**
	No	150	72.1	

**$p < 0.001$, Chi-square test.

Table II. Distribution of the extracted teeth according to tooth type.

	Extracted teeth		
Tooth type	*n*	%	*p*
Mandibular central incisors	10	13.2	0.392
Mandibular lateral incisors	5	6.6	
Mandibular canines	10	13.2	
Mandibular first premolars	9	11.8	
Mandibular second premolars	14	18.4	
Mandibular first molars	11	14.5	
Mandibular second molars	12	15.8	
Mandibular third molars	5	6.6	
Total mandibular teeth	76	100	
Maxillary central incisors	22	16.7	0.001**
Maxillary lateral incisors	22	16.7	
Maxillary canines	23	17.4	
Maxillary first premolars	21	15.9	
Maxillary second premolars	14	10.6	
Maxillary first molars	17	12.9	
Maxillary second molars	12	9.1	
Maxillary third molars	1	0.8	
Total maxillary teeth	132	100	

**$p < 0.001$, Chi-square test.

Results

Table I represents the relationship of extraction with respect to demographic characteristics of the study population. A total of 208 extracted crowned teeth belonging to 75 patients were evaluated in the study. Forty-three (57.3%) of the patients were females, whereas 32 (42.7%) were males. The average age of the patients was 63.21 ± 13.56 years. Eighteen (24%) of the patients were smokers and 60% of the individuals had a systemic condition, of which diabetes comprised 19.2%. Another common systemic condition related with the evaluated patients was hypertension, with an incidence of 13.1%. No significant correlation was detected in favor of a specific gender in terms of tooth extraction ($p = 0.127$).

A statistically significant relationship was determined between age groups and ratio of tooth extractions, with the lowest numbers of extractions detected in the 35–44 years age group and the highest in the 55–64 years age group ($p = 0.001$).

Table II shows the distribution of extractions according to tooth type. In general, the most frequently extracted tooth type was detected as maxillary canines followed by maxillary central and lateral incisors and maxillary premolars. Maxillary teeth comprised 63.1% of the evaluated teeth, whereas this ratio was 36.5% for the mandible. The ratio of extractions in the maxilla was significantly higher than the mandible ($p = 0.001$).

The motivations of patients for presenting to the hospital are summarized in Table III. One hundred and ten (52.9%) of the patients had initially presented to the clinics with complaints of tooth mobility, 41 (19.7%) with complaints of pain, 22 (10.6%) with esthetic concerns and 35 (16.8%) due to other reasons such as treatment of another tooth, gingival problems, sinus tract, general check-up and prosthetic purposes.

Table IV shows the distribution of extraction reasons. The most encountered reason for tooth extraction was periodontal reasons with a prevalence of 59.1%, followed by caries (26.9%) and periapical lesions (12%).

In Table V the ages of coronal restorations are shown. The ages of crowns varied between 3–20 years, with an average age of 9.35 ± 3.25. The highest rate of extractions was performed on crowned teeth between 6–10 years of age.

Table VI represents specific information about the conditions of extracted teeth. The incidence of bridge abutments among the extracted teeth was significantly higher than crowns ($p = 0.001$).

The majority of the crown restorations received a Charlie score (crevice at margin, dentin exposed) indicating a bad marginal adaptation.

A significant correlation was determined between poor marginal adaptation of the crown (Charlie scores) and extraction ($p = 0.001$); 15.9% of the extracted teeth also served as abutments for removable prosthesis, whereas 8.7% included intraradicular posts.

A significant correlation was determined between the condition of the post and extraction. Teeth with unsatisfactory posts (ex: short, inadequate diameter,

Table III. Reasons of patients for presenting to the hospital.

Reasons	*n*	%
Pain	41	19.7
Mobility	110	52.9
Esthetics	22	10.6
Trauma	—	—
Other reasons	35	16.8
Problem related to another tooth	22	10.6
Periodontal problem	7	3.4
Sinus tract	3	1.4
General check-up	2	1.0
Prosthetic	1	0.5

long) were more frequently extracted with a statistical significance (p = 0.049); 66.7% of the extracted teeth had cast posts as intra-radicular support, whereas the remaining 33.3% contained standard pre-fabricated posts, all of which were threaded stainless steel.

Of the extracted teeth, 64.4% did not have any endodontic treatment. When the quality of endodontic treatment was analyzed, it was found that 60 teeth (81.1%) had incomplete root fillings. There was a significant relationship between extractions and incomplete root fillings (p = 0.001).

Table VII summarizes the distribution of extraction reasons according to quality of marginal adaptation. Among 168 cases with poor marginal adaptation of crowns, 102 (61%) were also associated with periodontal disease.

Discussion

Building a crown is one of the options that dental practitioners can select while encountering severely damaged teeth in dental practice. These types of restorations are relatively more expensive and time-consuming compared to directly placed restorations, especially if an intra-radicular post placement is also

Table IV. Reasons for tooth extractions.

Reasons for tooth extractions	*n*	%
Periodontal disease	123	59.1
Caries	56	26.9
Periapical lesion	25	12.0
Prosthetic	3	1.4
Endodontic failure	1	0.5
Fracture	—	—
Perforation	—	—
Orthodontic	—	—
Esthetic	—	—

Table V. The ages of coronal restorations evaluated in the study.

	Extracted teeth	
Age of the fixed prosthesis	*n*	%
0–5 years	28	13.5
6–10 years	92	44.2
11–15 years	86	41.3
16–20 years	2	1.0

necessary. On the other hand, ensuring a long time survival of the tooth and the placement of a more robust restoration are other driving factors for the selection of a full-crown for the compensation of the lost dental tissues and function [13]. Placement of crowns has been described as a helpful means to limit tooth fracture and maintenance of oral function and morphology of a tooth for a long period [14]. Also, some studies have specifically concluded in favor of a full cuspal coverage following endodontic treatment to increase the longevity of teeth, referring to the fact that teeth receiving root canal treatment are more susceptible to fracture [15]. On the other hand; fixed prosthetic applications also pose some shortcomings. The preparation of teeth for fixed prostheses usually involves extensive removal of enamel and dentin. It has also been stated that the application of a variety of dental materials and operative procedures on the prepared tooth may have significant biological consequences for the dental pulp. There is also the possibility of luting cements to dissolve in the oral environment depending on the material properties and fit of the fixed prosthesis [16].

It is significant in these types of studies that each dentist's choice for extraction is valid in order to prevent bias [8]. In the present study, this possible shortcoming was minimized by the fact that each patient admitted to the university clinic went through detailed examinations by each related discipline before a final decision was rendered. The routine procedure at the university clinic is an initial examination at the Dentomaxillofacial Radiology Department following which the patients are referred to the related sections where a further evaluation is undertaken. In case a doubt arises regarding the choice of treatment, a collaborative approach is made by consultation with other disciplines. Consequently, it may be considered quite unlikely that an unnecessary intervention occurred because an accumulation of ideas from all disciplines was carefully evaluated and a consensus was reached before the decision about extraction was made. Richards et al. [17] commented that the reasons for extractions given by dental surgeons included in their study have not been validated and could reflect the subjectivity of clinical decision-making. Such subjectivity is not quite expected in the present study as the diagnosis

Table VI. Specific information about the conditions of extracted teeth.

		Extracted teeth		
		n	%	*p*
Jaws	Maxilla	76	36.5	0.001**
	Mandible	132	63.5	
Crown or bridge abutment	Crown	39	18.8	0.001**
	Bridge abutment	169	81.3	
Marginal adaptation of the crown	Alpha	12	5.8	0.001**
	Bravo	28	13.5	
	Charlie	168	80.8	
Abutment for a removable prosthesis	Yes	33	15.9	0.001**
	No	175	84.1	
Presence of intra-radicular posts	Yes	18	8.7	0.001**
	No	190	91.3	
Condition of the post ($n = 18$)	Satisfactory	5	27.8	0.05*
	Unsatisfactory	13	72.2	
Type of post ($n = 18$)	Cast post	12	66.7	0.157
	Prefabricated post	6	33.3	
Presence of endodontic treatment	Yes	74	35.6	0.001**
	No	134	64.4	
Quality of endodontic treatment	Adequate	10	13.5	0.001**
	Underfill	60	81.5	
	Overfill	4	5.4	

*$p < 0.05$; **$p < 0.001$, chi-square test.

had already been established with the consultation of different disciplines before the patient was admitted to extraction. On the other hand, different results may be obtained in case a similar study is conducted covering general practitioners who do not have the opportunity to work collaboratively and who generally make their subjective decisions regarding tooth extraction. It is doubtful whether all dental practitioners rely on radiographic images prior to making a decision about a specific tooth. In some cases, detailed radiographic interpretation may be missed and a tooth which is more suitable for extraction may be preserved.

Table VII. Distribution of extraction reasons according to quality of marginal adaptation.

		Distributions of teeth according to the extraction reasons	
Criteria of marginal adaptation	Number of teeth (%)	*n*	Reasons
Alpha: Restoration is continuous with existing anatomic form, explorer does not catch	12 (5.8%)	5	Periapical lesion
		5	Periodontal disease
		2	Caries
Bravo: Explorer catches, no crevice is visible into which explorer will penetrate	28 (13.5%)	1	Periapical lesion
		16	Periodontal disease
		11	Caries
Charlie: Crevice at margin, dentin exposed	168 (80.8%)	19	Periapical lesion
		102	Periodontal disease
		43	Caries
		1	Endodontic failure
		3	Prosthetic

Conversely, a tooth that may otherwise be saved and be used as an abutment may be extracted due to lack of experience and adequate armamentarium of the general practitioner.

It has been indicated that reasons that govern the longevity of restorations and failures can be related to biologic factors or to technical and patient-related factors. On the other hand, a shortcoming of studies evaluating the survival or extraction reasons is that a stable population is difficult to obtain. This is clear from the available literature that studies focusing on this topic are based on the private practices as well as university undergraduate and specialist clinics [18]. Approaches of these healthcare givers may somewhat differ in terms of decision and prognosis, resulting in obtaining incomparable data. The present study was conducted at a university clinic which may show a rather more comprehensive approach to the patients' needs.

In general, the most frequently extracted tooth type was determined as maxillary canines followed by maxillary central and lateral incisors and maxillary premolars. The ratio of extractions in the maxilla was significantly higher than the mandible ($p = 0.001$). An examination of the literature reveals mandibular first molars as the most frequently extracted type of teeth most probably due to their susceptibility to caries. In a study examining the reasons of extraction of endodontically treated teeth, it was concluded that mandibular first molars followed by second and third mandibular molars comprised the highest proportion of cases involved in an emergency consultation [1]. A similar result has been obtained in a study in France [5], yielding high frequencies of extractions for first and second molars. A study in Afghanistan [19] determined a higher incidence of extractions for posterior teeth and noted that the main reason for the extraction of posterior teeth is rather due to caries, whereas anterior teeth are more prone to be extracted due to periodontal reasons. Maxillary anterior teeth were determined to be extracted more frequently in the present study contrary to the results of some previous studies which concluded a higher incidence of extraction for molars and which aimed to evaluate the reasons of extraction in general, not focusing on a specific group of teeth such as the present study. Since this study specifically focused on teeth with full crown and considering that the main reason for extraction was tooth mobility related with periodontal factors, it seems logical that anterior teeth were determined to be extracted more frequently. A similar conclusion has been drawn by Chrysanthakopoulos [20]. Stabholz et al. [2], in a study evaluating the reasons for tooth loss in geriatric patients, determined incisors and molars as the most frequently extracted teeth followed by premolars and canines, and determined periodontal disease as the major cause for tooth loss. Their study evaluated patients aged 65–95 years attending for extraction. Considering that 72.1% of the patients in the present study were individuals above 55 years of age, it is natural that extractions were primarily performed due to periodontal factors. Consequently, it can be expected that anterior teeth comprise the higher proportion owing to their susceptibility to periodontal diseases compared to posterior teeth.

Male gender has been reported as a risk indicator for periodontal severity and extraction was reported to be more common among males due to periodontal reasons [21]. This has been confirmed by some previous studies [3,22]. On the other hand, the results of the present study reveal no statistically significant difference between genders concerning periodontal disease. Diabetes and smoking were determined to be pre-disposing factors for periodontal disease with a statistically significant difference ($p = 0.001$), which is consistent with the results of previous reports [23,24].

It is appropriate to mention the major reason for the failure of fixed dental prosthesis not necessarily resulting in extraction. Loss of retention, biological problems (caries, periodontal and endodontic disease), esthetic problems, fracture of abutment teeth or metallic substructures have been reported as the major causes of failure in fixed dental prosthesis [25]. It has further been recommended that maintenance is a very significant element in the provision of a long-lasting restoration and prevention of biologic failures. In the present study, there was vague information with respect to previous follow-up of patients so it is impossible to make a deduction regarding the impact of oral health maintenance on the results obtained. There is yet no established system in the country that enables the clinician to trace the patients' previous dental records, so the only way to receive information about previous dental treatment or follow-ups was to rely on patients' personal declarations. Even though some patient proportion included in the study may have undergone regular maintenance as understood from their own words, this situation cannot be generalized for the whole study population tested. Meanwhile, there might always be the risk of patients who are over- or under-represented in these types of studies regarding dental awareness as well as socio-economic status. Similar comments were made by Van-Nieuwenhuysen et al. [26]. These authors further determined that partial composite restorations in premolars showed the lowest, whereas crowns in molars showed the highest survival rates and the frequency of failures was higher for premolar than molar restorations. Additionally, they obtained a 75% survival rate for crowns over 10 years. They attributed this relatively lower survival rate to the high number of endodontically-treated teeth among the crowns.

Although crowns are good alternatives for the maintenance of oral function, it has been indicated by some authors that crowns should not be considered

as the first choice of treatment to severely damaged posterior teeth with poor prognosis for endodontic or periodontal reasons [26]. They further commented that extensive amalgam and composite restorations can be used as intermediary restorations in these situations, later to be used as a sub-structure for a subsequent crown. On the other hand, in a study by Miyamoto et al. [27], teeth with complete crowns were determined to have fewer restorative failures when compared with teeth with multi-surface restorations. Extensive restorations may especially be helpful in cases where periodontal problems accompany extensive dental tissue loss. Monitoring the progression of the periodontal problem after the placement of an intermediate extensive amalgam or composite restoration may be a more suitable means of managing these cases. Also, this approach may be beneficial for the patient as well in terms of economical concerns considering the fact that crowns are only partially reimbursable by insurance companies in many countries. One shortcoming of such an approach may be the technical difficulty of placing these restorations as a level of skill and expertise is rendered necessary. Consequently, dental practitioners must be enthusiastic to improve their competencies in these challenging cases to provide a more beneficial service to their patients in cases where they are indicated. Nevertheless, it is questionable whether these restorations extend a similar service in the mouth as crowns and it is our opinion that their usage should be restricted to cases which require monitoring and economical circumstances limit the possibility of a more expensive type of restoration.

Touré et al. [1], in a study evaluating the reasons of extraction of endodontically-treated teeth, determined that only 5.9% of teeth with root canal treatment were restored by crowns. Zadik et al. [28] also noted that 85% of the extracted endodontically-treated teeth were without full cuspal coverage. The results of the present study indicate that 35.6% of the extracted crowned teeth had undergone endodontic treatment. Although it is presumed that a full crown minimizing leakage plays a favorable role in the prognosis of endodontically-treated teeth, the result determined in the present study re-emphasized the necessity of a qualified endodontic treatment for a favorable prognosis, as a significant portion of the evaluated teeth had incomplete root fillings.

A significant association with apical periodontitis and coronal restoration has been found in a milestone study performed by Ray and Trope [29]. In the present study, 12% of the evaluated teeth were referred for extraction due to periapical lesions. Considering the fact that, at a university clinic, the patients are always offered the opportunity of endodontic treatment in case of periapical lesions or the option of a re-treatment is offered if a previous endodontic treatment has failed, it can be speculated that the aforementioned percentage of teeth were those cases that are presumed to be unsalvageable even by the Endodontics specialists who are generally involved in very challenging cases. In the meantime; prior to the initiation of an endodontic treatment, the negative odds of the prognosis are always introduced and the patient's decision is also taken into consideration after all the pros and cons are presented and informed consent is received depending on the choice of treatment. Some of these cases may be those types of periapical lesions of extensive magnitude whose prognosis was described as uncertain to the patient and a strategy was made according to the patient's selection of treatment.

Intra-canal posts are useful adjuncts in the restoration of teeth with severe damage of coronal structure to provide adequate support. On the other hand, they may bring along the disadvantage of predisposing teeth to fractures due to weakened roots and wedging forces depending on their shape. In the present study, 8.7% of the extracted crowns had previously received a post as a retentive element. It has been suggested that a custom-cast post design is morphologically less likely to result in tooth or post-fracture [30]. On the other hand, parallel-sided posts may lead to over-preparation of the apical third of the root canal resulting in perforations or oblique root fractures [31]. An apical seal of a minimum of 5 mm of root-filling material has been recommended for a successful post restoration [32]. The types of posts used underneath crowns were determined by visual examination from the radiographs which revealed that the major proportion of the posts were custom-cast. Meanwhile, the type of core after the removal of the crown reconfirmed the type of post (custom-cast or prefabricated) used underneath the crown.

Vertical root fractures have been defined as a catastrophic type of failure, leading to extraction. Fuss et al. [33] have described vertical fractures as the third most common reason for extraction after restorative and endodontic factors. On the other hand, lower percentages have been obtained in some other investigations [34]. In the present study, no vertical root fractures were determined in spite of careful visual examination following tooth extractions. The null percentage of these types of failures determined in the present study may be related with the evaluation of teeth with full crowns. Since teeth with a full crown may show better resistance to external impacts leading to catastrophic vertical fractures, a result such as the one detected in the present study can be expected. A higher percentage of vertical fractures were detected in the study by Fuss et al. [33]. These authors attributed the higher percentage of vertical fractures observed in their study to the fact that the final diagnosis of vertical root fractures was carried out after the tooth/root was extracted and the fracture could be demonstrated visually. It is

noteworthy to indicate that the aforementioned study did not specifically concentrate on crowned teeth. A similar observation methodology was carried out in the present study to confirm the presence of vertical fractures. On the other hand, it is always possible that micro-cracks of small magnitude might have been missed by visual inspection. Nevertheless, the null percentage of this type of failure may be attributed to the limitation of the study to full crowns which may have the potential to withstand external forces.

The population included in the present study presumably consisted of individuals of similar economic status. Such a deduction was made depending on the fact that extractions were performed on patients who sought service from a university specialty clinic where the patients are charged for the specific dental procedures and do not benefit from their social security. The results of some studies have been criticized by authors for potential bias due to the sample being recruited from lower socio-economic backgrounds [17]. It is also true that studies performed in populations of different socio-economic status may yield different results. An example that can be given to this parameter is the study by Haikola et al. [35], which concluded that social factors were more prominently associated with edentulousness than factors related to general health. Furthermore; Akin et al. [36] found a significant difference between education and income levels and prosthodontic needs.

Miyamoto et al. [27], in a study evaluating failure of teeth relative to their treatment history, determined that removable partial denture abutments experienced the highest failure rate. It is likely that these teeth may be subjected to more stress than a regular crown; thus may be more prone to failures. In the present study, only 15.9% of the evaluated extracted teeth also served as abutments for removable partial dentures. Kapur et al. [37] also reported a low failure incidence for abutments of removable prostheses. On the other hand, a strict adherence to follow-up visits should be encouraged by dentists in these cases with strategic importance in order to enhance the long-term prognosis. Similar comments were made by Miyamoto et al. [27]. Another note to be mentioned is that incorrect planning of the prosthodontic treatment may also contribute to increasing the load the abutment teeth need to withstand.

Within the limitations of this study, it can be concluded that periodontal factors seem to predominate other reasons that lead to extraction of teeth with crowns/bridges. Maxillary anterior teeth with crowns/bridges exhibit a higher frequency of extractions. There seems to be an even distribution among genders when extraction of crowned teeth is concerned.

This study is focused specifically on crowned teeth referred for extraction at a university clinic and provides a general overview regarding the major reasons that inevitably require tooth extraction. It is clear that if precautions can be taken adequately prior to prosthetic planning, undesirable consequences such as tooth extraction may be prevented or at least delayed until after a reasonable time of clinical usage.

Studies comprising other faculty clinics as well as general practices are warranted and will be complementary in making more generalized statements and developing strategies for the maintenance of crown and bridges restorations which have significant medical and economic impacts on the community.

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