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Original Article

Indications & predisposing factors of crown lengthening surgery

Arghavan Amini -Behbahani(DDS)[1], Farin Kiany (DDS)[2]✉, Bahareh Farsizadeh[3]

1. Assistant Professor, Department of Periodontics, Dental School, International Branch of Shiraz University of Medical Sciences, Shiraz-Iran.

2.Assistant Professor, Department of Periodontics, Dental School, Shiraz University of Medical Sciences, Shiraz-Iran.

3. Dental Student, Research Committee, Dental School, International Branch Shiraz University of Medical Sciences, Shiraz-Iran.

✉**Corresponding Author:** Farin Kiany, Dental School, Shiraz University of Medical Sciences, Shiraz- Iran.

Email: farinkiany@yahoo.com **Tel:** +989173152796

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Abstract

Introduction: Since crown lengthening surgery could be accompanied by stress, pain and discomfort, knowledge about its predisposing factors could reduce the demands for such surgery.The aim of this study was to identify the most important indications of crown lengthening surgery in order to present new ideas to clinicians on how to reduce the need for this surgery.

Methods: This cross-sectional study was done on 470 patients (aged 12-89 years) referred for crown lengthening surgery. The patients' demographic data and their reasons for surgery, the teeth restoration condition and its type, condition of the opposite tooth, type of fractured cusp (posterior teeth), root canal therapy condition and quality, and size of existing intracanal posts were recorded in a data sheet. Data were analyzed by using SPSS software.The chi-square and fisher exact test were used for statistical analysis. The significant difference was $p<0.05$.

Results: The most frequent indication in men and women was dental caries followed by tooth fracture.The second upper premolars and first lower molars needed crown lengthening surgery more often, respectively.

Conclusions: Since dental caries and fracture are the most important factors that predispose teeth to crown lengthening surgery, controlling caries with a regular recall sequence can reduce the need for such surgery, especially in the elderly.

Keywords: Crown lengthening, Dental caries, Tooth fractures, Root canal therapy

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اندیکاسیونها و فاکتورهای مستعدکننده جراحی افزایش طول تاج

ارغوان امینی بهبهانی، فرین کیانی*، بهاره فارسی زاده

چکیده

مقدمه: ازآنجائیکه جراحی افزایش طول تاج می تواند برای بیمار همراه با استرس، درد و ناراحتی باشد، شناخت موارد منجر به این جراحی می تواند سبب کاهش نیاز به انجام این جراحی گردد. هدف از انجام این مطالعه، شناخت مهمترین علل نیاز به انجام جراحی افزایش طول تاج می باشد تا بتوان ایده های نوینی را در راستای چگونگی کاهش نیاز به این جراحی در پیشروی کلینیسین ها قرار دهد.

مواد و روش ها: این مطالعه به صورت مقطعی و بر روی ۴۷۰ بیمار (۱۲-۸۹ سال) ارجاع داده شده برای جراحی افزایش طول تاج انجام گرفت. فرم اطلاعاتی تنظیم شده برای بیماران شامل سن، جنس، شماره دندان مورد نظر، علت نیاز به جراحی، وضعیت ترمیم دندان و نوع آن، شرایط دندان مقابل، کاسپ شکسته (در مورد دندانهای خلفی)، وضعیت درمان ریشه و کیفیت آن و اندازه پست داخل کانال ثبت گردید. داده ها توسط نرم افزار SPSS 20 آنالیزگردید. برای آنالیز داده ها از تستهای Chi – square و fisherś exact استفاده شد. $p< 0.05$ نیز به عنوان اختلاف معنی دار در نظر گرفته شد.

یافته ها: مهمترین علت ها در مردان و زنان در درجه اول پوسیدگی و در درجه بعد شکستگی بود. بیشترین دندان های نیازمند جراحی افزایش طول تاج به ترتیب پرمولرهای دوم بالاو مولرهای اول پایین بودند.

نتیجه گیری: با توجه به اینکه پوسیدگی و شکستگی به ترتیب بیشترین عوامل مستعدکننده دندان به جراحی افزایش طول تاج می باشند، به نظر می رسد کنترل پوسیدگی همراه با توالی معاینات منظم می تواند تا حد زیادی نیاز به جراحی افزایش طول تاج را به ویژه در سنین بالا مرتفع نماید.

واژگان کلیدی: افزایش طول تاج، پوسیدگی، شکستگی، درمان ریشه

Introduction

The aim of restorative dentistry is to maintain the health and function of the dental system alongside providing dental beauty. Therefore, all dental restorations should be performed with respect to maintaining the health and physiology of the periodontium. Some conditions such as caries, fractures and subgingival extension of previous restorations could necessitate subgingival placement of restoration margins that could in turn threaten periodontal health. [1, 2]

Biologic width is defined as a volume of soft tissue that is connected to a tooth above the alveolar bone crest and its length is approximately 2.04 mm. [3,4]Clinical studies showed that the extension of restorative margin to this zone could cause gingival inflammation and resorption of the crestal alveolar bone.[5-7]This is particularly important when the intact tooth margin is located in close proximity to the crestal alveolar bone due to complications such as caries, fractures, or coronal root perforations. Therefore, in order to maintain the health of the periodontium which is threatened by marginal extension of restorations during restorative procedures, crown lengthening surgery is indicated.[8] Since crown lengthening surgery could be accompanied by stress, pain and discomfort, knowledge about its predisposing factors could reduce the demands for such surgery.

In many cases, the improvement of restorative methods could reduce the need for replacement of restorations that would most often necessitate crown lengthening surgery. This study aimed to identify the most important indications of crown lengthening surgery in order to present new ideas to clinicians on how to reduce the need for this surgery.

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Methods

This cross-sectional study was conducted on adults referred to periodontist for crown lengthening surgery in Fajr and Naft Dental Clinics in Shiraz, southern Iran, from April 2012 to December 2012.

The research proposal was reviewed and approved by the research ethic committee of the dental school, international branch, Shiraz University of Medical Sciences.470 patients were included in the study after clinical examination for confirmation of the possibility of maintaining the tooth via crown lengthening surgery. The exclusion criteria were as follows: low possibilities for endodontic and restorative treatments, probability of furcation involvement during surgery, threatening of dental aesthetics at the smile line, no strategic value for the tooth in future treatment plan, substantial damage to bone support of adjacent teeth upon surgery and inadequate remaining root structure for supporting future prosthesis regarding crown/root ratio.[9]

The patients' demographic data as well as data regarding the indication of surgery, the teeth restorative condition and its type, condition of the opposite tooth, scheme of fractured cusp (posterior teeth), root canal therapy condition and quality and the size of existing intracanal posts were recorded in a data sheet. The data regarding whether the tooth needed surgery for several reasons or several fractured cusps were also recorded. The indications for crown lengthening surgery were classified in eight general categories[10]: excessive gingival display, subgingivally extended restorations, inadequate restorative retention, crown fracture with subgingival extension, caries with subgingival extension, subgingival perforations of crown/root, short clinical crown and other indications.

Excessive gingival display was defined as the increase of fibrotic gingival volume or lack of apical gingival migration to the cementoenamel junction (CEJ) which necessitated the apical relocation of the gingival margin. Subgingival restoration was implied when the tooth had been filled with restorative material but it scheduled to be restored with full crown and then it needed surgery to provide a ferrule effect.

Inadequate retention group consisted of teeth with full crown but inadequate preparation that needed relocation of finishing line.Subgingival caries and fracture as well as subgingival perforation consisted of cases who were candidate for full crown when the healthy tooth margin distance to the bone was less that 4 mm and so biologic width violation was likely. Short clinical crown consisted of teeth with inadequate space for construction of crowns. Those conditions were because of improper previous preparation of tooth or owing to the closure of the interocclusal space due to attrition, caries or fracture, or because of providing no adequate space to the bone crest by the finishing margin of a healthy prepared tooth.

Data were analyzed by using SPSS (version 20) software. The chi-square and fisher exact test were used for statistical analysis. The significant difference was $p<0.05$.

Results

176 and 294 of 470 patients participated in this study were men and women with a mean±SD age of 38.43±14.16 years (range: 12-89 years), respectively. Considering that more than one tooth of some patients needed surgery, 504 teeth were ultimately included in our study. 292 (57.9%) were maxillary teeth and the rest were mandibular teeth.

The second upper premolars and first lower molars needed crown lengthening surgery more often, respectively. The third upper molars and lower incisors needed surgery least often, respectively. Moreover, among the various teeth types, upper premolars and lower molars needed the most surgeries.

Based on the obtained data, the indications for crown lengthening surgery were reclassified into six categories. Accordingly, the most frequent indications in men and women were dental caries followed by tooth fracture. Other frequent indications included excessive gingival display, subgingival restoration, and short clinical crown, respectively.

There was a significant difference between the men and women with respect to excessive gingival display and caries ($p<0.001$), but there were no statistically significant differences in other indications. Among included teeth, 42 teeth needed surgery due to two above-mentioned reasons (table1). In the next step, the prevalence of the most frequent indications (fracture and caries) was assessed in 3 different age groups (<30, 30-50, >50 year).[11] Caries was most prevalent in all age groups, especially among patients who were more than 50 years old with the prevalence of twice as much as dental fracture.

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Table 1. Frequency (%) of the various indications for crown lengthening surgery based on sex

Indication	Men N(%)	Women N(%)	P-value
Excessive gingival display	0(0%)	36(100%)	<0.001
Subgingival restoration	9(37.5%)	15(62.5%)	0.768
Inadequate restoration attachment	0(0%)	3(100%)	0.177
Fracture	70(35.7%)	126(64.3%)	0.463
Caries	120(44.6%)	149(55.4%)	0.001
Short clinical crown	5(27.8%)	13(72.2%)	0.376

Patient who were 30-50 years old needed surgery more than others, followed by those who were less than 30 years old. Moreover, excessive gingival display had the least mean±SD age (16±6.19 years) and subgingival restoration and short clinical crown had the highest mean±SD age (46.91±10.9 and 44.28±11.32 years). It was found that the highest rate of fracture was related to the teeth restored with amalgam compared to the teeth receiving other restorations (p<0.001), followed by composite resins, no restored teeth, and full crown. Moreover, in all cases except teeth restored with amalgam, the most prevalent indication for crown lengthening surgery was not fracture (p<0.001)(table 2).

Table 2. The relationship between different restorations and dental caries (numbers are presented as frequency [%])

Caries Restoration	Yes N(%)	No N(%)
None	117(71.1%)	72(28.9%)
Amalgam	53(26.4%)	148(73.6%)
Composite	8(50%)	8(50%)
Crown	31(81.6%)	7(18.4%)

The highest rate of fracture was seen in teeth with Distoocclusal(DO) (59 [80.8%]) and Mesioocclusodistal (MOD)(73 [68.2%]) restorations (p=0.061) compared with those with Mesioocclusal (MO) restorations (21 [56.8%]). In cases with involvement of buccal or lingual surfaces other than mesial and/or distal surfaces, categorization was done based on mesial and distal surfaces. A significant relationship was not found between tooth fracture and post length (P=0.108) or thickness (P=0.064).

However, the type of post affected teeth fracture so that the indication for surgery in all cases with casting posts was fracture. Yet, teeth fracture did not differ from other indications in prefabricated posts. However, the fracture was seen in one third of cases using amalgam pin.

It was found that teeth receiving endodontic treatment experienced fracture more than non-endodontically treated teeth (p=0.001); however, the quality of treatment did not significantly affect teeth fracture with respect to the density of the root canal filling material (p=0.82). Furthermore, there was no significant relationship between the existence of peri-apical lesion and fracture (table 3).

Table 3. The relationship between endodontic treatment and dental fracture (numbers are presented as frequency [%])

Fracture Root treatment	Yes N(%)	No N(%)
None	61(22.8%)	207(77.2%)
Complete	102(57.6%)	75(42.4%)
Incomplete	33(55.9%)	26(44.1%)

Finally, there was no significant relationship between the type of restoration in opposite teeth and rate of fracture. Opposite teeth were categorized into six groups (nonrestored, filled, crown, removable denture, implant, and no teeth). There was a significant relationship between different restorations and rate of caries. Dental caries was more prevalent in teeth with full crown than intact teeth and teeth filled with composite and amalgam, respectively.

Discussion

The present study aimed to assess the most important indications for crown lengthening surgery. It is found that the deep subgingival caries and crown fracture extending subgingivally were the most important indications for crown lengthening, respectively. Deep subgingival caries can be caused by delay in detecting caries due to the patients' lack of knowledge about the necessity of treatment, lack of

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periodic check-ups, financial problems, or fear of dental treatments. Crown fracture as the second most important indication for crown lengthening also emphasizes the need for following emergency situations on the patients' behalf. Moreover, improper restorative treatment planning especially for endodontically treated teeth could also predispose the tooth to fracture and so intensify the need for crown lengthening.

In this study, crown lengthening for aesthetic reasons was indicated only in the <30 year-old age group which seemed logical considering the youth's beauty-seeking sensations. Supra-eruption, severe coronal destruction and inadequate inter-occlusal space could lead to short clinical crowns and inadequate retention of restoration were seen more frequently in older patients.

These patients may also have shorter crowns over time or after detachment of previous crowns, without experiencing crown fracture or developing new caries. In individuals who were over 50 years of age, dental caries was the most important reason for crown lengthening surgery which was also twice the rate of the other factors. However, there was no considerable difference in younger age groups.

This can be attributed to the fact that in elders, teeth are harder and more resistant to fracture because of dentinal sclerosis. Moreover, the amount of dental caries increases because of more restorations, crowns and root exposure due to gingival recession.[12,13]

The prevalence of caries was higher in teeth restored with crown, intact teeth, composite resins and amalgam filled teeth, respectively. It can be attributed to strengthen the teeth structure and reduce fracture ratio. Moreover, the recurrence of caries under crowns is higher because of the inaccessibility for cleaning the teeth and the inability of the dentist to check the recurrent caries.[14-18]

The second upper premolar and first lower molar needed crown lengthening surgery more than others and upper wisdom teeth and lower incisors needed it less than others. It can be related to the distal orientation of upper wisdom teeth which limit their strategic value in prosthetic treatment plans so they are preferably extracted rather than restored.[19-22]

Lower incisors are also less prone to caries or fracture because of their easy accessibility for cleansing, continuous secretion of saliva around them, small surface, and lower stress.[23]The second upper premolar has symmetrical shape but it has no furcation and less vital role in dental aesthetics compared with other maxillary teeth; therefore, it has fewer limitations for being maintained via crown lengthening surgery compared with extraction.

The likelihood of dental caries and restoration is higher in first lower molar perhaps because of its early eruption to the oral cavity that prolongs its contact with deleterious agents.[24]Moreover, considering its strategic situation in prosthetic treatment plans, preserving of this tooth has a high priority.

Since the focus of this study was mainly on teeth that had the chance to be maintained by crown lengthening surgery, the teeth, which were scheduled for extraction, were not statistically analyzed. Therefore, it cannot necessarily be concluded that the above-mentioned teeth have the highest risk of fracture and/or caries; because other teeth might not have enough efficiency to be maintained by considering these complications.

Comparing fractured teeth with different restorations, the most fracture prevalence was seen in teeth restored with amalgam and composite, followed by intact teeth and teeth restored with crown. The effect of these restorations can be attributed to the impact of these treatment modalities on strengthening or weakening the remaining tooth structure.[25,26]With respect to the extension of restorations, Mesioocclusodistal(MOD) and Distoocclusal(DO) restorations exhibit more fractures compared with Mesioocclusal (MO) restorations.[27]Considering the mandibular joint model which is a third-class lever, maintaining the distal marginal ridge seems critical to maintain teeth integrity against joint forces.

There were no significant differences with respect to the type of restoration of the opposite teeth and its effect on tooth fracture. It seems that teeth fracture occurs as a result of accumulating minor stresses over a long period of time which is considered as the teeth's fatigue strength.[28]

Based on previous studies, even if the force is excruciated by the crown or implant, it can only shorten the needed duration for tooth fracture without affecting its amount. In such cases, the minimum contact on the prosthesis is considered to reduce forces.

The most frequent fractured cusp in upper posterior teeth was the palatal cusp which was

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inconsistent with previous studies. [29-31]The most frequent fractured cusp in the lower premolars was the buccal cusp and in the lower molars was the lingual cusp. Of course, this means that teeth with such characteristics can be maintained. For instance in this study, the buccal cusp fracture was seen more frequently in lower molars that had to be extracted**.** However, this contradictory finding was not observed in other teeth groups.

Similar to previous studies, the teeth which underwent RCT experienced cusp fracture more than other teeth. This might be due to the weakening of the tooth structure caused by the destruction of the inner dentin layer which can transfer stress to the external parts of the tooth.[32]Since the suitable density of gutta-perca did not have any effect on teeth fracture rate compared with its weak density, it could be concluded that compressive stresses made during root canal filling with gutta-perca did not have any adverse effect on teeth fracture in long term.

Fracture in teeth with casting posts was less than those with prefabricated posts. This could be attributed to accurate adaptation of casting posts with the root canal walls that causes vast stress distribution in teeth and prevent stress accumulation in the crown area. Moreover, in some cases post and core are made together and do not have the ability to move separately. Height and thickness of posts were also not impressive on teeth fracture because a post's function was to create retention and durability against vertical forces, while forces that cause teeth fracture were horizontal and inclined.

Conclusions

Since dental caries and fracture were the most predisposing factors for crown lengthening surgery, controlling caries with a regular recall sequence could reduce the need for such surgery, especially in the elderly. Considering a suitable restorative treatment plan for endodontically treated teeth (such as cusp coverage) or restoration with crowns can help to reduce the need for crown lengthening surgery especially when the distal marginal ridge of teeth has been lost.

Moreover, using custom-made posts can solve many of these complications. It should be emphasized that the findings of this study were about the teeth that could be maintained with crown lengthening surgery. More extensive studies can be conducted considering each of indicative factors in both groups of teeth (including maintainable &non-maintainable).

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