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ANALYSIS OF SURVIVAL OF ORTHOPEDIC METHODS FOR RESTORATION OF TOTAL HARD TISSUE DEFECTS OF TEETH IN THE MANUFACTURE OF FIXED DENTAL CONSTRUCTIONS

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The restoration of teeth with significant or complete destruction of the crown tooth part is one of the urgent problems of orthopedic dentistry. The aim of the study was to improve the quality of orthopedic treatment for patients with significant or complete destruction of the crown part of the tooth by analyzing the survival rate of stump pin inserts manufactured using an enhanced methodology. Therefore, the conducted research has demonstrated that the application of our enhanced methodology for fabricating stump pin inserts allows preventing root perforations of supporting teeth and reducing the percentage of inadequate marginal adaptation from 22.4 % to 1.2 %. Overall, the number of complications arising during the usage of CSPI has decreased from 25.3 % to 2.8 %, increasing their survival from 52 % to 96 %. Based on the "Decementation" criterion, survival has increased from 77.5 % to 98.5 %, "Secondary caries process" from 78.5 % to 97 %, and "Root fracture or crack" from 96. 5% to 99.5 %.

Key words: orthopedic treatment, total defect, cast stump pin insert, survival, glass ceramics.

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АНАЛІЗ ВИЖИВАНОСТІ ОРТОПЕДИЧНИХ МЕТОДІВ ВІДНОВЛЕННЯ ТОТАЛЬНИХ ДЕФЕКТІВ ТВЕРДИХ ТКАНИН ЗУБІВ ПРИ ВИГОТОВЛЕННІ НЕЗНІМНИХ СТОМАТОЛОГІЧНИХ КОНСТРУКЦІЙ

Відновлення зубів зі значним чи повним руйнуванням коронкової частини зуба є однією з актуальних проблем ортопедичної стоматології. Метою дослідження було підвищення якості ортопедичного лікування пацієнтів зі значним або повним руйнуванням коронкової частини зуба шляхом аналізу виживаності куксових штифтових вкладок, виготовлених за удосконаленою методикою. Проведене дослідження показало, що застосування удосконаленої нами методики виготовлення куксових штифтових вкладок дозволяє запобігти перфораціям коренів опорних зубів та зменшити відсоток неякісного крайового прилягання з 22,4 % до 1,2 %. Загалом кількість ускладнень, які виникають під час використання КШВ зменшилась з 25,3 % до 2,8 %, збільшивши їх виживаність з 52 % до 96 %. За критерієм «Розцементування» виживаність збільшилась з 77,5 % до 98,5 %, «вторинний карієс» – з 78,5 % до 97 %, «Тріщина кореня» – з 96,5 % до 99,5 %.

Ключові слова: ортопедичне лікування, тотальний дефект, куксова штифтова вкладка, виживаність, склокераміка.

The study is a fragment of the research project "Restoring the quality of life of patients with major dental diseases of the organs and tissues of the maxillofacial area with the help of orthopedic treatment and rehabilitation", state registration No. 0122U000350.

Untimely treatment of caries leads to the development of its complications, which require endodontic treatment. At the same time, the restoration of hard tooth tissues with the help of light-curing composites is not always effective and requires the involvement of orthopedic dentistry methods [4]. The analysis of the data published in the scientific literature showed that the restoration of teeth with significant or complete destruction of the crown tooth part is one of the urgent problems of orthopedic dentistry [6, 7, 8]. One of the directions in solving this problem is the preservation of tooth roots suitable for prosthetics, thereby preventing the formation of defects and deformations of the dental rows, atrophy of alveolar processes [11].

It should be noted the special importance of preserving the roots of the teeth, if their not always justified removal leads to the formation of the final defect of the dentition [9].

To restore the stumps of destroyed teeth, the most common and reliable metal cast stump pin insert (CSPI) are successfully used. Despite the application of modern technologies in everyday practice for prosthetics of patients with significant or complete destruction of the crown part of the tooth, the complication rate remains high [3]. According to research by domestic and foreign authors, the percentage of complications ranges from 4 % to 11 %, with the most common complications including: root splitting, which can be caused by thinning of the canal walls, as well as incorrect pin geometry and the design of the cast stump insert itself, which can also contribute to functional traumatic overload of teeth caused by prognathia or deep bite; decementation of the CSPI, the cause of which may be insufficient retention of the pin in the tooth root canal or a short pin; as well as partial decementation, the consequence of which may be the release of metal ions into the oral cavity and the body as a whole; secondary caries and decementation of the artificial crown due to significant convergence of the walls of the cast stump pin insert [5, 10].

The relevance and scientific-practical significance of the problem of prosthetics in patients with significant or complete destruction of the crown part of the tooth, as well as the high percentage of complications associated with this type of prosthetics, have become the scientific-theoretical basis for the research we have chosen.

The purpose of the study was to improve the quality of orthopedic treatment for patients with significant or complete destruction of the crown part of the tooth by analyzing the survival rate of stump pin inserts manufactured using an enhanced methodology.

Materials and methods. The study was conducted at the Department of Orthopedic Dentistry, University Dental Center, Kharkiv National Medical University.

Deontological aspects are resolved within the framework of the legislation in force in Ukraine, the Law of Ukraine "On Medicines", 1996, Art. 7, 8, 12, principles of ICH GCP (2008), order of the Ministry of Health of Ukraine No. 690 of 23.09.2009 "On approval of the Rules for clinical trials and expertise of materials of clinical trials and model regulations on the ethics commission", as amended; World Health Association Declaration of Helsinki. Patients were fully informed about the purpose and methods of the study, the potential gains and risks, and the possible discomfort with the diagnosis and treatment. All ethical requirements for maintaining the confidentiality of the information received during the study are fulfilled.

To achieve the set goal, an examination and orthopedic treatment were conducted on 170 patients with significant or complete destruction of the crown part of the tooth, aged 27 to 63 years, including 98 males and 72 females. Metal stump pin inserts and metal-ceramic crowns were fabricated for them. All patients were divided into 2 groups. The first (control) group consisted of 75 individuals (41 males, 34 females) who underwent the standard prosthetic methodology using cobalt-chromium alloy for fabricating stump pin inserts fixed with glass ionomer cement "Fuji +". The second (experimental) group included 95 patients (42 males, 53 females) who received treatment with an enhanced methodology, involving the application of a computer program developed by us and a non-eugenol plastic material for modeling the reproduction of stump pin inserts. Additionally, a cobalt-chromium alloy structure with glass-ceramics was applied. The fixation material used was similar for both groups.

The formation of the database based on the results of randomized controlled trials was carried out using Microsoft Excel, 2015. Statistical analysis of the research results was conducted using the software package "Statistica v. 8.0". The Kaplan-Meier method was applied to assess survival. This non-parametric method for evaluating the survival function allows determining the proportion of patients who did not experience a "critical" event and estimating the probability of "survival" up to a specific point in time [1, 2].

Results of the study and their discussion. The primary indicator of the quality of orthopedic treatment for patients with significant or complete destruction of the crown part of the tooth is the number of complications that may arise both during the fabrication of stump pin insert and their usage. The data obtained during our study are presented in Tables 1 and 2. The observations conducted revealed that root perforations during the application of the standard methodology could occur in 0.76 % of cases for single-rooted teeth and in 3.39 % for multi-rooted teeth. At the same time, this complication was successfully avoided in patients of the experimental group through the use of an enhanced methodology, as all parameters and characteristics of the future construction were known in advance.

Table 1

Complications arising during the fabrication of cast stump pin inserts

Criterion	Standard technique (n=250)				Improved technique (n=250)			
	SR (n=132)		MR (n=118)		SR (n=121)		MR (n=129)	
	abs.	%	abs.	%	abs.	%	abs.	%
Perforation during preparation	1	0.76	4	3.39	-	-	-	-
Poor edge fit	23	17.42	32	27.11	1	0.77	2	1.55

Table 2

Complications that arise during the use of cast stump pin inserts

Criterion	SR/ MR	Standard technique (n=245, where n(SR)=131, n(MR)=114)						Improved technique (n=250, where n(SR)=111, n(MR)=129)					
		1 year		3 years		5 years		1 year		3 years		5 years	
		abs.	%	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
Decementation	SR	5	3.82	11	8.39	19	14.5	-	-	1	0.9	1	0.9
	MR	2	1.77	6	5.3	13	11.5	-	-	-	-	1	0.77
Secondary caries process	SR	3	2.29	8	6.1	14	10.7	1	0.9	1	0.9	2	1.8
	MR	4	3.5	10	8.8	12	10.6	-	-	-	-	2	1.55
Root fracture or crack	SR	2	1.52	2	1.52	3	2.29	-	-	-	-	1	0.9
	MR	-	-	1	0.8	1	0.8	-	-	-	-	-	-
Total		16	6.53	38	15.5	62	25.3	1	0.4	2	0.8	7	2.8

Another significant complication that may occur is the inadequate marginal adaptation of cast stump pin inserts to the hard tissues of the tooth. The study revealed incidences of this complication at 17.42 % and 27.11 % for single- and multi-rooted teeth, respectively, when applying the standard methodology. Analysis of treatment results with the enhanced methodology showed a reduction in the occurrence of this type of complication to 0.77 % for single-rooted teeth and 1.55 % when fabricating stump pin inserts for multi-rooted teeth.

At the next stage, a study was conducted on complications arising during the usage of CSPI. Based on the "Decementation" criterion (Fig. 1), when applying the standard methodology for fabricating CSPI for single-rooted teeth, complications were observed in 3.82 % of cases within 1 year (96 % survival), in contrast to the enhanced methodology, where no decementations were detected during the same period (100 % survival). The subsequent 3-year period showed an increase in the number of decementation complications in the control group to 8.39 % (88 % survival). During the same time frame, among 111 patients in the experimental group, only 1 complication appeared, representing 0.9 % (99 % survival), and this rate remained unchanged until the censoring moment. Regarding the application of the standard methodology, the probability of survival continued to decrease, reaching 73 %, as 19 cases of decementation of CSPI in single-rooted teeth were identified within 5 years in this group.

Among 113 CSPI in multi-rooted teeth fabricated using the standard methodology, decementation occurred in 1.77 % within the first year (98 % survival), and over 3 years, it was observed in 5.3 % (93 % survival). In contrast, enhanced inserts in multi-rooted teeth showed 100 % survival during the same period. Over the subsequent time interval until censoring, the number of complications in the control group increased to 11.5 %, resulting in a decrease in survival to 82 % based on this criterion. In the experimental group, only 0.77 % decementations were recorded, yielding a 99 % survival rate.

The investigation of the "Secondary caries process" criterion (Fig. 2) revealed that in the control group, complications occurred in 2.29 % of patients during the fabrication of single-rooted CSPI within the first year, resulting in a survival rate of 97.7 % at this stage. In the subsequent period, the number of complications increased to 6.1 % (91 % survival), and in the final stage, it reached 10.7 % (81 % survival).

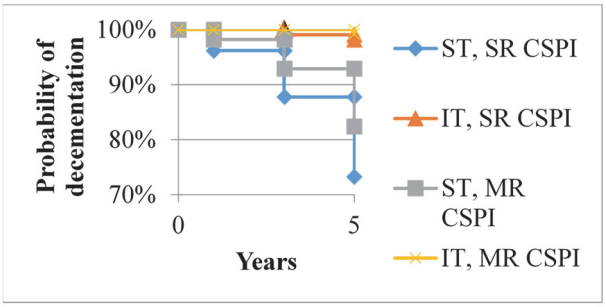

Fig. 1. Probability of decementation

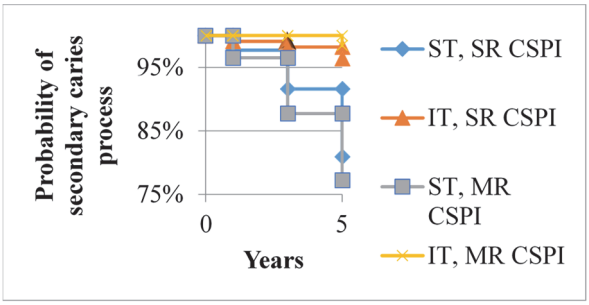

Fig. 2 Probability of secondary caries process

Meanwhile, in the experimental group of single-root CSPI, only 0.9 % of complications were recorded during the first stage, which did not increase over 3 years, with a survival rate of 99 %. At the censoring moment, one additional complication was identified, accounting for 1.8 %, and the survival rate decreased to 96 %. However, the difference between the groups is a significant 15 %.

Secondary caries process when using stump pin inserts in multi-rooted teeth with the standard methodology was identified in 3.5 % within the first year, 8.8 % after 3 years, and 10.6 % at the final stage. The survival rate was determined to be 77 %.

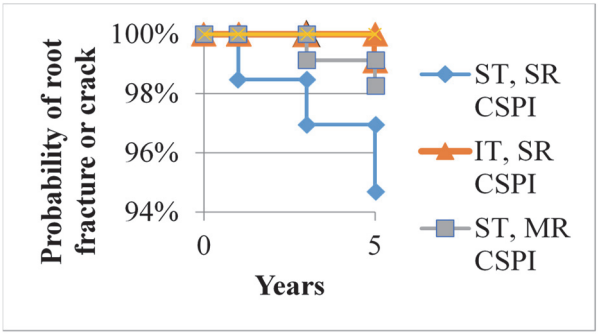

Fig. 3 Probability of root fracture or crack

In the corresponding subgroup using our enhanced methodology MR CSPI, no cases of secondary caries were detected over 3 years, and at the censoring moment, it was recorded in only 1.55 %, resulting in a survival rate of 98 %.

Root fracture or crack (Fig. 3) was identified in patients of the control group SR SPI already in the first year of the study at 1.52 % (98 % survival). The incidence remained unchanged over 3 years but increased to 2.29 % until censoring, reducing the survival rate for this parameter to 94 %, unlike the rate for patients in the experimental group, which is 99 %, as root fracture was detected only in 1 case. As for CSPI in multi-rooted teeth, the application of the standard methodology resulted in the identification

of 1 complication in the second stage, with a survival rate of 99 %. With the use of the enhanced methodology, no such complications were recorded, achieving a survival rate of 100 %.

Of particular interest in order to reduce the number of complications in the manufacture of CSPI is the distribution of masticatory pressure. It should be borne in mind that the distribution of elastic stresses has a complex character, which is determined by the geometric shape of the teeth, their spatial and structural heterogeneity. The study of these conditions makes it possible to determine the most vulnerable places for plastic deformations and destruction of hard tissues of the teeth and to choose a prosthesis design that has optimal biomechanical properties [8]. When discussing this issue in special scientific literature, as a rule, data obtained by the photoelasticity method are used [6].

To date, a program for calculating stresses in the hard tissues of a tooth under the influence of an external force has been developed and implemented (E. N. Zhulev, T. Yu. Makhkamov, 2002). It is based on the use of standard systems of differential equations of the theory of elasticity, which are solved numerically by the relaxation method [3].

However, a theoretical calculation using a mathematical model can provide more complete information, and the improved technique proposed by us allows to significantly improve the quality of orthopedic treatment of patients with significant destruction of the crown part of the tooth.

Conclusion

Therefore, the conducted research has demonstrated that the application of our enhanced methodology for fabricating stump pin inserts allows preventing root perforations of supporting teeth and reducing the percentage of inadequate marginal adaptation from 22.4 % to 1.2 %. Overall, the number of complications arising during the usage of CSPI has decreased from 25.3 % to 2.8 %, increasing their survival from 52 % to 96 %. Based on the “Decementation” criterion, survival has increased from 77.5 % to 98.5 %, “Secondary caries process” from 78.5 % to 97 %, and “Root fracture or crack” from 96.5 % to 99.5 %.

Thus, the analysis of the survival of stump pin inserts demonstrates a significant improvement in the quality of orthopedic treatment for patients with significant or complete destruction of the crown part of the tooth when using the enhanced methodology, providing a favorable prognosis for their usage according to various criteria.

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