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Periotest values of abutment teeth during prosthetic treatment with removable partial dentures

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Actuality. Periotest (PT) is a diagnostic method, which allows for detection of the initial changes in the pathological mobility of teeth or dental prostheses. This method also allows for observation of the dynamics of changes in the periodontium after carrying out dental treatments.

The purpose of this study is to monitor Periotest values (PTV) in patients who use fixed and removable partial denture therapy (FPD, RPD) during different periods, and analyze this data depended on tooth type and load from FPD and RPD.

Materials and methods. 50 patients were examined, performed PT and assessed tooth mobility according to the Miller mobility index (MMI) in the Center of Dentistry of the University Clinic of IFNMU: 39 persons were treated partial edentulous with FPD and RPD – research group; 11 people with healthy dentition - the control group. PTV and MMI were carried out before prosthetics and 1, 2 and 3 years after. The examined teeth were divided depending on the load that fell on them from the fixing elements (I-III groups) and according to their morpho- functional type (incisors, canines, premolars and molars).

Results. The average PTV before treatment was 13.09±2.82 c.u. for incisors, 8.79±3.02 c.u. (canines), 13.15±3.12 c.u. and 9.08±2.36 c.u. (premolars and molars). A significant increase in PTV was observed in the I group after two and three years of prostheses use compared to data before prosthetic treatment by 47.1% and 92.96% for incisors, 22.07% and 30.94% for canines and by 42.35% and 82.67% for premolars ($p \leq 0.05$). PTV of premolars of II group increased by 31.42% after 3 years. PTV of all teeth of the III group were significantly decreased compared with data before treatment.

Determination of teeth mobility according to MMI was not informative in most cases, except a mobility decrease of incisors of the III group after prosthetic treatment, and an increase of mobility of incisors, canines and premolars of the I group after 3 years of RPD use, compared to pretreatment data, ($p \leq 0.05$).

Key words: abutment teeth, tooth mobility, partial removable prostheses, fixed prostheses, Periotest

Introduction

Fixed and removable partial denture (FPD, RPD) therapy is an adequate and economically acceptable form of treatment for patients with partial edentulous. Their design should be provided using biomechanics principles, which focuses on the distribution of forces in the supporting tissues for retention and stability. [1]. Denture base shape, denture construction and especially the number, position of the abutment teeth and clasps influence periodontal condition [2].The periodontal health is essential for successful prosthetic treatment, satisfied and functional rehabilitation [3, 4].

The main reason for the failure of this treatment is the loss of abutment teeth due to periodontal changes [5, 6].It has been noted the use of RPDs could not aggravate periodontal conditions after 18 months of follow-up, and that the maintenance of periodontal follow up is beneficial for such patients [7].

To evaluate periodontal tissue condition is necessary to carry out a clinical examination, assessment of the teeth mobility degree and an X-ray. Changes in the mobility degree of the abutment teeth may indicate the onset of an inflammatory process, impaired blood supply, and functional overload of periodontal tissues [8]. The risk of losing abutment

teeth increases because of overloading, which leads to a new need for prosthetic treatment in the short term [9].

Usually, dental practitioners assess tooth mobility according to the Miller mobility index (MMI, 1950), which consists in moving of the tooth held between the metallic handles of two instruments in the buccolingual or buccopalatal direction. The moved distance is visually estimated and then classified into Grades 0–3.Though it may provide valuable information for the diagnosis only of moderate and severe periodontitis [10].

Among the methods of determining of the tooth mobility, Periotest (PT) is highly informative. It is known that Periotest value (PTV) assessment is associated with the ability to detect initial, even minimal changes in the pathological mobility of the examined teeth/FPD and to observe positive or negative dynamics of changes in the periodontium after dental treatment, including prosthetic treatment [11].

It is especially important to diagnose the condition of the periodontal tissues in patients with partial tooth loss during planning prosthetic treatment with both FPD and PRD for functional restoration of the maxillofacial system and the long-term functioning of the abutment teeth [12]. Also, it is necessary to monitor the supporting tissues conditions in patients during the use of prostheses to timely identify areas of periodontal overload and prevent its progression. However, the arsenal of techniques for achieving these goals is limited.

Use of PT has become widespread when adjusting the load force in orthodontics [13, 14, 15]. Also, it is used for evaluating the implants integration in bone tissue [16]; evaluating the level of abutments stability during prosthetic treatment based on implants [17]. Another study evaluated the relationship between PTV and marginal bone loss around single dental implants [18].

Also, it was indicated the direct dependence of PTV on the level of bone tissue resorption and the role of traumatic occlusion in the fluctuations of this data [19]. Lukas D et al. established correlations between PTV and the condition of periodontal tissues, determined the key role of the bone resorption (the multiple quadratic correlation=61%) on the growth of PTV. Ishigaki S et al. concluded that PT provides clear quantitative data of traumatic occlusion factors [20]; even in teeth with periodontal tissues diseases [21]. Another area for PT applying is monitoring the condition of the periodontal tissues of teeth after traumatic injuries to evaluate the stiffness of the splint used in the treatment [22].

However, the use of PT in complex clinical situations, especially during simultaneous treatment with FPD and RPD, remains insufficiently studied. It is unclear if there is a difference in the mobility of patients' teeth depending on their type, load from prosthesis and the period of its use.

Therefore, ***the purpose of our study*** was: to monitor changes of tooth mobility and PTV in patients who use FPD and RPD together during different periods of time, and analyze this data depended on tooth type and load from FPD and RPD.

Materials and methods

In a longitudinal study, patients presented to the Center of Dentistry of the University Clinic of IFNMU with partial edentulous for prosthetic treatment within the framework of state scientific research № 0119U003667 “Comprehensive research of morphological, functional and clinical properties of supporting tissues and their value in prosthetic treatment with removable dentures”. Medical history taking, examinations and therapeutic procedures were conducted by general dentists before the prosthetic stage. The patients were counselled about different variants of dental prosthetic rehabilitation. In case of further treatment with FPD and RPD made due to Protocols of dental care approved by the Ministry of Health of Ukraine (*http://medstandart.net/browse/1597*) they could become eligible subjects for the study [23]. RPD were made of acrylic resins, which are the most used in prosthetics until now because of well-documented history of use of this biomaterial in the manufacture of different types of dental appliances [24]. FPD were presented by metal-ceramic crowns and bridges.

The study was conducted over a period of 4 years from April 2018 to December 2021. During this time 62 patients had a request for treatment and were enrolled due to **inclusion criteria:** persons of age group of 55–70 years without acute forms of periodontal diseases and good level of individual oral hygiene. **Exclusion criteria** was presence of endocrine pathology and severe forms of systemic diseases. Due to these criteria 13 patients were excluded and a further 10 declined participate. That leaves 39 who

underwent through the study (Fig. 1). During the study it was made in total 61 RPDs (17 patients had PRD on one jaw and 22-on both).

Study Setting

For each patient a clinical investigation was conducted which included tooth mobility assessment by using MMI and PT, which evaluates the ability of periodontal tissues to restore the initial position of the tooth after a certain external load (functional or pathological) [11]. The PTV of each examined tooth was calculated as the arithmetic mean of 4 measurements. Assessments were done before prosthetic treatment and after one, two and three years of dental prostheses use.

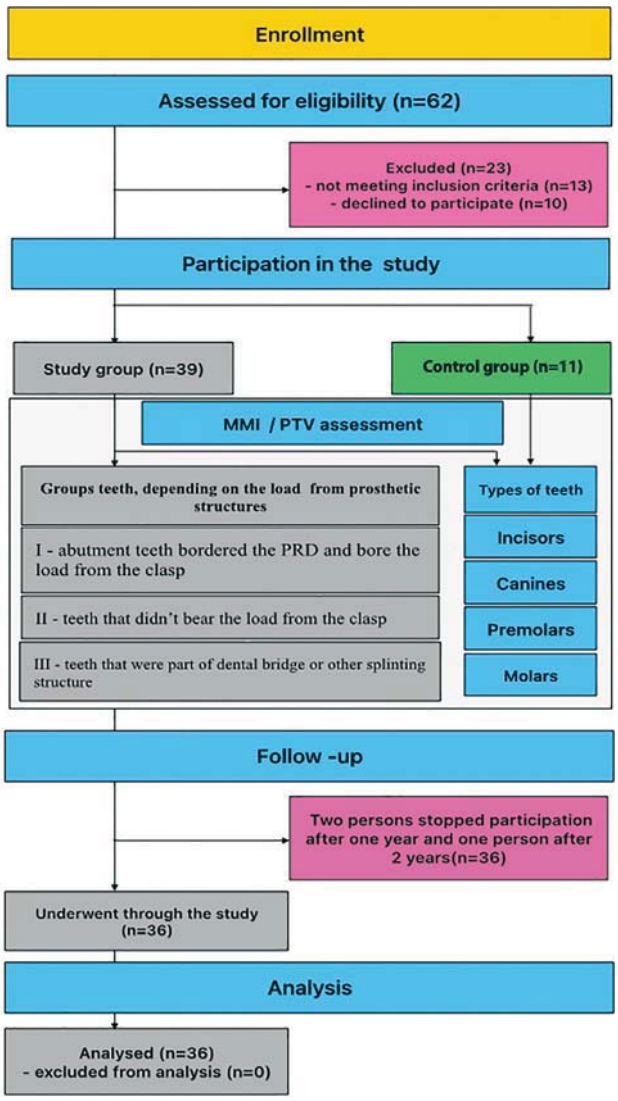

Figure 1. Study Setting Flow Diagram

Assessment of Main Group

During follow-up, 3 patients out of 39 have dropped out of the study (Fig. 1); finally, main group included 36 patients (age – 61±5.2 years). All assessments of the teeth were arranged to three groups, depending on the load that fell on them from prosthetic structures: abutment teeth bordered the PRD and bore the load from the clasp - I group (54 teeth); teeth that didn't bear the load from the clasp – II group (37teeth,); teeth that were part of dental bridge or other splinting structure – III group (60 teeth). The examined teeth were divided according to morphological type into incisors (48 teeth), canines (39 teeth), premolars (45 teeth) and molars (19 teeth).

Assessment of Control Group

Control group involves 11 patients (age –59±3.32 years) without tooth loss and without periodontal tissues diseases. According to morphological type, in the control group were assessed: incisors – 72; canines – 36; premolars – 70; molars – 108.

Statistical analysis

Statistical processing was carried out using Excel Office 365 software (Microsoft, USA) and Online Web Statistical Calculator https://astatsa.com. The significance of the difference in average values in the study group was determined by One-way ANOVA for repeated measures with post-hoc Tukey HSD Test at the level of $p<0.05$ and the Manna-Whitney test was used for comparison with control group ($p<0.050$).

Results

Average PTV of different types of teeth in control group, and in patients with partial tooth loss (main group) before treatment with RPD and FPD and after using them for one, two and three years depending on tooth type and the load that fell on them from dental prostheses are shown in Table 1.

The average PTV in our sample of patients were significantly higher, compared to the control group data: in the group of incisors by 2.9 times, canines by 3.7 times, premolars, and molars by 4,8 and 5,24 times, respectively ($p<0.05$).

There was a significant increase in the average PTV of abutment teeth of I group among incisors, canines, and premolars after two and three years of using RPD, compared to the PTV before treatment. Also, there was a significant increase among incisors and premolars

Table 1

The average PTV/MMI of the examined teeth before/after prosthetic treatment (Mean±SE), c.u.

groups of teeth formed depending on the load that fell on them		I (216)	II (148)	III (240)
Incisors				
control group		4.51±1.59" / 0.14±0.35		
before prosthetic treatment		11.93±3.97 / 0.8±0.63	12.98±2.70 / 0.85±0.9	13.62±2.28 / 1.08±0.9
after use of prostheses for	1 year	14.05±3.38 / 1.1±0.87	13.35±2.80 / 0.61±0.96	6.83±2.58^ / 0.36±0.49$
	2 years	17.55±4.47*,+ / 1.4±0.52	13.71±3.40 / 1.07±0.76	7.15±2.19^ / 0.32±0.48$
	3 years	23.02±3.67*, **,+ / 1.7±0.48#	14.69±3.35 / 1.23±0.83	7.50±2.24^ / 0.44±0.5$
Canines				
control group		2.39±1.87" / 0.05±023		
before prosthetic treatment		8.79±3.1 / 0.33±0.49	9.61±2.96 / 0.33±0.5	9.87±2.92 / 0.33±0.49
after use of prostheses for	1 year	9.22±2.64 / 0.87±0.74	8.42±2.15 / 0.56±0.53	4.07±1.31 / 0.27±0.46^
	2 years	10.73±2.33+ / 1.07±0.8#	8.5±1.91 / 0.67±0.5	5.4±1.45 / 0.2±0.41^
	3 years	11.51±2.2+ / 1.2±0.86#	8.81±1.89 / 0.44±0.53	5.52±1.38 / 0.27±0.46^
Premolars				
control group		2.74±1.94" / 0.08±0.28		
before prosthetic treatment		12.35±3.35 / 0.9±0.83	13.59±3.07 / 0.73±0.65	14.08±2.63 / 0.85±0.8
after use of prostheses for	1 year	15.21±3.55 / 1.04±0.92	14.09±2.92 / 0.64±0.8	6.37±1.48 / 0.3±0.48^
	2 years	17.58±4.43 / 1.38±0.8+	15.75±4.13 / 1.18±0.6	7.06±1.61 / 0.38±0.5 ^
	3 years	22.56±3.86*, **,+ / 1.71±0.46#	17.86±4.15+ / 1.37±0.67	7.87±1.33 / 0.46±0.5^
Molars				
control group		1.73±1.66" / 0.07±0.26		
before prosthetic treatment		8.94±2.3 / 0.37±0.52	8.94±2.54 / 0.25±0.5	9.32±2.7 / 0.43±0.53
after use of prostheses for	1 year	10.22±2.53 / 0.87±0.83	8.56±1.4 / 0.25±0.5	5.32±0.73 / 0.28±0.49^
	2 years	10.56±2.75 / 0.87±0.99	8.94±2.08 / 0.5± 0.58	5.79±1.37 / 0.14±0.38^
	3 years	12.19±2.08 / 1.25±0.89	9.81±1.6 / 0.5±0.5	6.07±1.74 / 0.28±0.49^

Notes: significances ($p<0.05$): " – a difference of the average PTV of teeth in control group, compared to data of persons with partial tooth loss before treatment;

^ – a decrease of the average PTV of teeth, compared to the data before prosthetic treatment;

+ – an increase of the average PTV of teeth, compared to the data before prosthetic treatment;

* – an increase of the average PTV of teeth, compared to the data after 1 years of use;

** – an increase of the average PTV of teeth compared to the data after 2 years of use;

– an increase of the average MMI of teeth, compared to the data before prosthetic treatment;

$ – a decrease of the average MMI of teeth, compared to the data before prosthetic treatment.

after three years, compared to PTV after one and two years ($p<0.05$). The average PTV of premolars of the II group was 31.42% higher 3 years after prosthetics, compared to pretreatment data ($p<0.05$). On the other hand, there was noted a significant decrease in the average PTV of all types of teeth in the III group one, two and three years after RPD use (by 34.87–58.78%), compared to the initial values ($p<0.05$).

Determination of tooth mobility according MMI did not allow to establish the dynamics of changes in the mobility of all groups of teeth of the II group. However, there was observed a significant increase in the mobility of the incisors and premolars after 3 years in the 1st group and among canines after 2 and 3 years of RPD use; there was noted a decrease in the mobility of the incisors during different periods in the III group, compared to the data before treatment, ($p\leq0.05$).

Discussion

Tooth mobility is an important indicator for deciding to include the tooth to the prosthetic structure [25]. PT allowed us objectively to determine an increase of the incisors and premolars mobility with increasing of load on them and time of RPD use, compared to their condition before prosthetic treatment. However, if the load of the fixation elements of the RPD is distributed over a fixed splinting structure, there was decreasing dynamics of tooth mobility among all morphofunctional types.

Our research methods are close to ones obtained by Fueki K et al., who established that the average PTV of abutment teeth with thermoplastic clasps after 3 months of using of PRD were significantly lower compared to those with metal clasps [26]. In our study, we note a significant increase in the PTV of teeth in the I group, that bore the load from the clasp but depending not on their material but time of PRD use (by 47.1% and 92.96% for incisors, by 22.07% and 30.94% for canines and by 42.35% and 82.67% for premolars after 2 and 3 years of use, respectively, compared to the data before prosthetic treatment). We agree with Fueki K et al. that PT is highly informative, compared to clinical methods of tooth mobility determining (MMI), which does not allow establishing changes in case of absence of clinical manifestations of pathological tooth mobility.

Similar study was conducted by Szentpétery V et al., who researched abutment teeth condition in patients after three years using RPD with fixation on telescopic crowns [27]. The authors observed a decrease in the average PTV of the supporting teeth values from 2.7 c.u. after fixation of dental prostheses to 8.7 c.u. during further use. We had the same dynamics in the III group where the abutment teeth were included in FPD which functioned like splints. In our opinion observed stabilization of the abutment teeth mobility in both cases are caused by more balanced load distribution between teeth and edentulous sites.

Conclusion

PT made it possible to informatively monitor the tooth mobility dynamics in patients who used RPD and FPD depending on the type of teeth and the load applied from prostheses, compared to MMI method.

The highest average PTV was observed among incisors and premolars, compared to canines and molars. An increase in PTV was observed with the time of RPD use, especially among the incisors (by 92.96%) and premolars (by 82.67%) which bore the load from the clasp after three years, compared to the pretreatment data. The most optimal conditions for the preservation and further effective functioning of abutment teeth of all types were noted when included them in fixed splinting structures with a decrease of PTV in the range of 34.87–58.78%, compared to values before prosthetics. Taking such data into account when planning the prosthetic treatment of partial edentulous with RPD and FPD, allows to avoid errors and complications associated with the pathological mobility of abutment teeth.

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Періотестометрія опорних зубів при ортопедичному лікуванні частковими знімними протезами

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Актуальність. Періотестометрія (ПТ) – діагностичний метод, який дозволяє виявити початкові зміни патологічної рухливості зубів або зубних протезів. Цей метод також дозволяє спостерігати динаміку змін в тканинах пародонту після проведення стоматологічного лікування.

Метою цього дослідження є моніторинг змін показників ПТ зубів у пацієнтів, що одночасно користуються незнімними ортопедичними конструкціями та частковими знімними пластинковими протезами (ЧЗПП), та аналіз цих даних залежно від типу зуба та навантаження від зубних протезів.

Матеріали і методи. У Центрі стоматології Університетської клініки ІФНМУ обстежено 50 пацієнтів, проведено ПТ та визначено рухомість зубів за індексом рухомості Міллера: 39 особам проведено ортопедичне лікування часткової адентії за допомогою ЧЗПП – дослідницька група; 11 осіб зі здоровими зубними рядами - контрольна група. Показники ПТ та рухомість зубів за індексом рухомості Міллера проводили до протезування та через 1, 2 та 3 роки після. Досліджувані зуби були розподілені залежно від навантаження, яке припадало на них від фіксуючих елементів (I-III групи) та за морфофункціональним типом (різці, ікла, премоляри та моляри).

Результати. Середні показники ПТ до лікування становили 13,09±2,82 у.о. для різців 8,79±3,02 у.о. (ікла), 13,15±3,12 у.о. і 9,08±2,36 у.о. (премоляри і моляри). Достовірне збільшення показників ПТ спостерігалося в I групі через два та три роки використання протезів порівняно з даними до протезування на 47,1% та 92,96% для різців, 22,07% та 30,94% для ікол та на 42,35% і 82,67% для премолярів. ($p \leq 0,05$). Показник ПТ премолярів II групи через 3 роки збільшився на 31,42%. Показники ПТ усіх зубів III групи були вірогідно знижені порівняно з даними до лікування.

Визначення рухливості зубів за Міллером в більшості випадків було неінформативним, за винятком зменшення рухливості різців III групи після протезування та збільшення рухливості різців, ікол та премолярів I групи через 3 роки використання ЧЗПП, порівняно з даними до протезування. ($p \leq 0,05$).

Ключові слова: опорні зуби, рухомість зубів, часткові знімні протези, незнімні протези, Періотест

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