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COMPARATIVE CHARACTERISTICS OF TRANSFERS SPLINTING TECHNIQUES IN THE PROCESS OF TAKING ONE-STAGE DOUBLE-LAYERED DENTAL IMPRESSIONS BY MEANS OF OPEN TRAY IMPRESSION TECHNIQUE

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Abstract. According to conclusions of ITI World Congress (2018), the accuracy of the dental impression determines the quality of the working model and, consequently, the fixation of the prosthetic restorations at the final stage. Inaccurate dental impression will inevitably lead to technical and biological complications (Wolfart S., 2016). According to Lee and co-authors (2019), the accuracy of the dental impression is influenced by the chosen method, namely closed or open tray, the presence or absence of transfers splinting and the choice of impression material type.

The most accurate impression has been proved to be an impression taken with the use of an open tray impression technique, by means of polyether impression material with preliminary transfers splinting using internally interfaced implant system.

The objective of the research was to evaluate the quality of implants placement transferring to the model by comparative analysis of different methods of clinical transfers splinting in order to take impressions using an open tray impression technique.

Twelve clinical situations were studied. Four groups were formed according to the method of transfer splinting. Each group included 3 clinical cases. Impressions were taken with the use of an open tray impression technique in all clinical cases with preliminary custom-made trays with holes in the implants projections.

A grading scale was created when assessing the quality of transfer splinting as a key factor in the accuracy of implant placement transferring.

Each of the groups received from 1 to 4 points where 1 point was the worst result according to this criterion and 4 points meant the best one. Among the criteria for splinting quality evaluation, 1-3 criteria were considered to be subjective, criterion 4 was considered to be objective. Therefore, criterion 4 received coefficient $\times 2$ in order to increase the objectivity of the results evaluation.

There were 4 criteria:

- 1) The simplicity of the technique and the time spent splinting.
- 2) The cost of the technique.
- 3) Passivity when fixing the bridge prosthetic restoration after manufacturing.
- 4) Radiologically measured distance between the centers of implant analogues on the model relative to each other after an impression taking by means of different splinting techniques and deviation of the value from the position of the centers of implants heads tops after osseointegration according to CT scan.

Analyzing the results of the research, splinting techniques were ranked according to the obtained points.

Research group 1 scored 6 points using dental floss and flowable compomer. A considerable amount of time was spent splinting with relatively inexpensive technology. The passivity of the fixation was the worst in comparison with other methods and the largest error was determined radiographically.

Group 4 scoring 17 points was determined as the best of the chosen techniques. Despite the high cost of the chosen technique, prosthetic restorations made after transfers splinting by means of this technique had the highest fixation accuracy and the lowest deviation of the implants analogues on the model radiographically in comparison with the position of the implants in the upper alveolar ridge and lower alveolar ridge due to the cost of the material based on poly-vinyl siloxane.

Keywords: implantation, open-tray impression, transfers splinting.

Introduction. The failures at the surgical stage of implantation constitute 2-3% of cases, whereas the failures occurring at the prosthetic stage increase to 12-18% [1].

According to the results of the meta-analysis of the scientific research conducted by Pjetursson and co-

authors [2], on the evaluation of complications of implantological treatment by prosthetic restorations, screw/abutment fixation relaxation occurs in 29% of all complications; veneering material chipping is noted in 11.9% of cases, fracture of a fixed restoration frame occurs in 3.0% of cases. These complications are generally explained by

insufficient passivity when fixing bridge restorations to the denture foundations, namely intraosseous dental implants.

Research rationale. The accuracy of the dental impression determines the quality of the working model and, consequently, the fixation of the prosthetic restorations at the final stage. Inaccurate dental impression will inevitably lead to technical and biological complications [3]. According to Lee and co-authors [4], the accuracy of the dental impression is influenced by the chosen method, namely closed or open tray, the presence or absence of transfers splinting and the choice of impression material type.

The objective of the research was to evaluate the quality of implants placement transferring to the model by comparative analysis of different methods of clinical transfers splinting in order to take impressions using an open tray impression technique.

Materials and methods of the research. After the implant osteointegration process was completed, a control CT scan was performed in order to evaluate the quality of the implant osteointegration processes. When the surgical stage was considered successful, the second stage of the treatment, namely the prosthetic one, was started.

Twelve clinical situations were studied. Four groups were formed according to the method of transfer splinting. Each group included 3 clinical cases.

Impressions were taken with the use of an open tray impression technique in all clinical cases with preliminary custom-made trays with holes in the implants projections.

A grading scale was created when assessing the quality of transfer splinting as a key factor in the accuracy of implant placement transferring.

There are different methods of transfers splinting: the clinical ones (directly in the oral cavity by an orthopedist) and the laboratory ones (manufacture of transfer-checks by a dental technician).

In the course of our work, clinical methods of transfer splinting were compared (Group 1 – splinting using a dental floss and flowable compomer; Group 2 – splinting using metal burr fixed to the transfers by quick-hardening plastic material with low level of shrinkage, Group 3 – splinting using glass fiber with a defined intertransfer distance fixed by flowable compomer, Group 4 – splinting using material based on Futar D Slow polyvinyl siloxane in order to connect transfers).

The transfer-check techniques were not used due to the large number of clinical and laboratory preparatory stages and the plan to compare only clinical methods of splinting in this scientific research.

The study groups comprised 4 splinting methods:

- Group 1 – after the healing screws were replaced by transfers, the transfers were bound by dental floss. Bounding was conducted with passive tension. Flowable compomer was applied at the site of the transfers contact with the dental floss and it was exposed to light. In order to ease the inner tension after the light polymerization of composite resin, the floss was cut into segments and exposed to light with photopolymer lamp with preliminary application of the composite resin at the

cutting site. Transfers splinting with the application of this method was conducted in case of I, II class diagnosis according to Kennedy and with the use of 3-4 intraosseous dental implants to replace the bilateral and unilateral free-end saddles of the dentition on superior jaw or inferior jaw.

- Group 2 – after the healing screws were replaced by transfers, metal burr was fixed to the surfaces of the adjacent transfers by quick-hardening plastic material with low level of shrinkage. The burr served a function of a rigid frame providing transfers splinting. Transfers splinting with the application of this method was conducted in case of I, II class diagnosis according to Kennedy and with the use of 2 intraosseous dental implants to replace the bilateral and unilateral free-end saddles of the dentition [5].

- Group 3 – after the healing screws were replaced by transfers, the intertransfer distance was determined with the use of periodontal probe. Glass fiber post was selected according to the determined distance. On fixing the glass fiber post to the transfers by means of flowable compomer, the corresponding accuracy of the fixing area was achieved due to the well-determined intertransfer distance. Transfers splinting with the application of this method was conducted in case of III, IV class diagnosis according to Kennedy and with the use of 2 intraosseous dental implants to replace bounded edentulous teeth and in case of such diagnosis as completely edentulous lower jaw and applied 4-8 intraosseous dental implants.

- Group 4 – after the healing screws were replaced by transfers, the material based on poly-vinyl siloxane was applied. Its properties (the material is of a particularly high final hardness and extended working time (3-4 minutes)) provide an opportunity to splint the transfers while preparing the basic materials to take one-stage double-layered dental impression. Transfers splinting with the application of this method was conducted in case of I, II, III, IV class diagnosis according to Kennedy and with the use of 2-4 intraosseous dental implants to replace edentulous teeth and in case of such diagnosis as completely edentulous lower jaw and applied 4-8 intraosseous dental implants.

All splinting methods provided free access to the transfer screw. After transfers splinting in all study groups, one-stage double-layered dental impressions were taken with the use of an open tray impression technique by means of A-silicone impression material combined with flowable correcting elastomeric poly-vinyl siloxane material which is of thixotropic character. The impressions were taken from implants with an internal hex connection.

Results of the research. A grading scale was created when assessing the quality of transfer splinting as a key factor in the accuracy of implant placement transferring.

Each of the groups received from 1 to 4 points where 1 point was the worst result according to this criterion and 4 points meant the best one. Among the criteria for splinting quality evaluation, 1-3 criteria were considered to be subjective, criterion 4 was considered to be objective. Therefore, criterion 4 received coefficient $\times 2$

in order to increase the objectivity of the results evaluation.

There were 4 criteria:

- 1) The simplicity of the technique and the time spent splinting.
- 2) The cost of the technique.
- 3) Passivity when fixing the bridge prosthetic restoration after manufacturing.

- 4) Radiologically measured distance between the centers of implant analogues on the model relative to each other after an impression taking by means of different splinting techniques and deviation of the value from the position of the centers of implants heads tops after osseointegration according to CT scan.

Analyzing the results of the research, splinting techniques were ranked according to the obtained points.

Table 1

Ranking of criteria according to the obtained points

CRITERIA	Group 1	Group 2	Group 3	Group 4
1.	1 point	3 points	3 points	4 points
2.	2 points	4 points	3 points	1 point
3.	1 point	2 points	3 points	4 points
4.	1×2 – 2 points	2×2 – 4 points	3×2 – 6 points	4×2 – 8 points
RESULT	6 points	8 points	15 points	17 points

Criterion 1 was assessed according to the time spent splinting manipulation. Preparation for the one-stage double-layered dental impression taking with the use of an open tray impression technique was known to take longer time than the impression taking itself, therefore it was important to minimize the preparation time including the choice of the optimal method of transfers splinting.

According to the conducted research, the transfer splinting method with the application of the material based on poly-vinyl siloxane (Group 4) took 1-2 minutes on average to splint the different number of transfers. This was the best result.

Taking into account the number of preparatory stages (transfers bounding by dental floss, flowable compomer application at the contact site, cutting the floss into segments in order to ease the tension), the time spent the transfers splinting by means of this method (Group 1) was considered to be the longest.

Analyzing splinting methods, attention was paid to the cost of consumable material required for the methods. Transfers splinting in Group 2 was conducted using metal burs fixed to the transfers by quick-hardening plastic with low level of shrinkage. It is worth noting that the used burs were no longer suitable for preparation but were perfect for the splinting. Therefore, Group 2 was considered to be the most economically available.

The method used for splinting in Group 4 received 1 point as the most expensive one due to the cost of the material based on poly-vinyl siloxane.

Criteria 3 and 4 were considered to be the most important for the assessment. Since the ultimate objective of impression taking was to manufacture an adequate restoration minimizing technical and biological complications, special attention was paid to the fixation passivity. Inaccuracies in restoration fitting are known to lead to contamination of microorganisms resulting in mucositis and peri-implantitis.

After the impression taking and laboratory stages of the prosthetic restoration manufacturing, fitting of

bridge restoration frame was carried out. All study groups were compared when intraosseous dental implants with an internal hex connection were fixed, therefore the error that could occur in case of comparison of the combination of hex and conical internal fit of implant and abutment was negated. The Sheffield test was conducted at the stage of bridge restoration frame fitting. The passivity of restorations fixation was evaluated.

The results of the research indicated a distinct advantage of the passivity of restorations fixation manufactured after splinting with the material based on poly-vinyl siloxane (Group 4). Restoration frames in Groups 1, 2, 3 were characterized by somewhat less passive but still satisfactory fixation in the oral cavity.

Criterion 4 was determined by cone beam computed tomography. After plastering of implant replica into a model casted from type 4 die stone, cone beam computed tomography of the model was conducted. The computer program measured the distance between the implant replicas splinted during the impression taking and compared with the position of the implants in the upper alveolar ridge and lower alveolar ridge according to the tomography performed at the stage of osteointegration processes evaluation before the implantological treatment.

The distance between the highest points of the centers of the adjacent implant heads was measured by means of the computed tomography of the patients' oral cavity. It was compared with the measured distance between the centers of the highest points of the implant replicas on the model manufactured after the impressions taking while conducting the transfers splinting of the respective study groups.

The computed tomography of the models and the patients included in the study groups was performed by Morita Veraviewepocs R-100 computed tomography scanner. The results were analyzed by means of the One-VolumeViewer computer program. The measurement was performed in the lateral projection.

Table 2

Ranking of splinting methods according to results of cone beam computed tomography (criteria 4)

Ranking of splitting methods according to results of cone beam computed tomography (criteria 4)						
Group №	Distance in the oral cavity, mm		Distance on the model, mm		AVERAGE DEVIATION, mm	POINTS (×2)
1	I – 6,79	II – 9,2	I – 6, 98	II – 9,31	0,16	2
	III– 7,38		III– 7,55			
2	I – 8,87	II – 10,1	I – 8,75	II – 10,2	0,13	4
	III - 6,01		III – 6,18			
3	I - 8,64	II – 6,98	I – 8,56	II – 7,08	0,09	6
	III – 7,55		III – 7,45			
4	I – 10,02	II – 8,25	I – 9,98	II – 8,28	0.036	8
	III – 7,78		III – 7,82			

Example of Measurement. This example relates to Group 3, clinical situation I.

The distance between the centers of the highest points of the implant heads fitted in the areas of missing 45 and 46 teeth was measured. The distance constituted 8.64 mm (Fig.1).

Implant replicas were plastered into a model after the one-stage double-layered dental impression taking using an open tray impression technique by means of transfers splinting with glass fiber and flowable com-

pomer with a predetermined inter-transfer distance (Fig. 2).

The distance between the centers of the highest points of implant replicas of 45 and 46 teeth was measured after the cone beam computed tomography of the model. The distance constituted 8.56 mm (Fig.3).

The difference between the indices (0.08 mm) was included in the mean deviation indices in order to rate the results of the research.

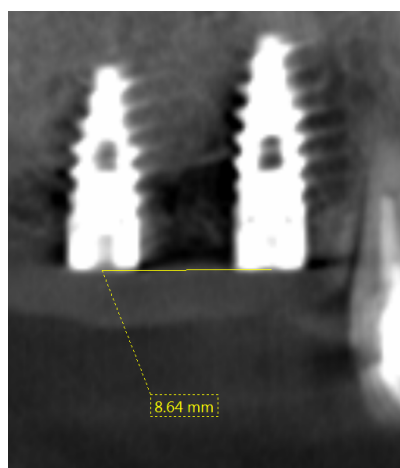


FIG. 1 The distance between the centers of the highest points of the implant heads



FIG. 2 Transfers splinting with glass fiber and flowable compomer

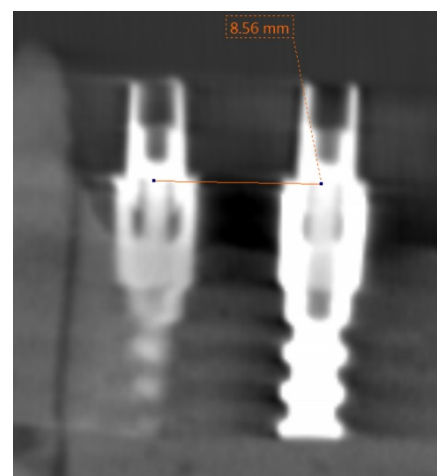


FIG. 3 The distance between the centers of the highest points of implant replicas

Discussion. The most accurate impression has been proved to be an impression taken with the use of an open tray impression technique, by means of polyether impression material with preliminary transfers splinting using internally interfaced implant system (According to conclusions of ITI World Congress, 2019) [6]. However, the variety of transfer splitting techniques and the choice of transfer splitting technique depending on the clinical situation remain unknown. Lee YJ [7] notes the advantages of laboratory splinting techniques over clinical ones. Our research has made it possible to unify the results of the most common methods of clinical splinting of transfers and to draw conclusions about the relevance of manipulation.

Conclusions. Research group 1 scored 6 points using dental floss and flowable compomer. A considerable amount of time was spent splinting with relatively inexpensive technology. The passivity of the fixation was the worst in comparison with other methods and the largest error was determined radiographically.

Group 4 scoring 17 points was determined as the best of the chosen techniques. Despite the high cost of the chosen technique, prosthetic restorations made after transfers splinting by means of this technique had the highest fixation accuracy and the lowest deviation of the implants analogues on the model radiographically in comparison with the position of the implants in the upper

alveolar ridge and lower alveolar ridge due to the cost of the material based on poly-vinyl siloxane.

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ПОРІВНЯЛЬНА ХАРАКТЕРИСТИКА МЕТОДИК ШИНУВАННЯ ТРАНСФЕРІВ ПРИ ЗНЯТТІ ОДНОЕТАПНИХ ДВОШАРОВИХ ВІДБИТКІВ МЕТОДОМ ВІДКРИТОЇ ЛОЖКИ

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Резюме. На VI Консенсусній конференції ІТІ (2018) групою експертів підтверджено, що найбільш точним методом зняття відбитків для виготовлення ортопедичних конструкцій з опорою на імплантати є відбиток методом відкритої ложки, знятий поліефірним відбитковим матеріалом із попередньо проведеним шинуванням трансферів при використанні систем імплантатів з внутрішнім з'єднанням.

Мета дослідження: оцінка якості перенесення положення імплантатів на модель шляхом порівняльного аналізу різних методик клінічного шинування трансферів для зняття відбитків методом відкритої ложки. Досліджено 12 клінічних ситуацій. Сформо-

вано 4 групи згідно з проведеною методикою шинування трансферів. У всіх клінічних випадках проводилося зняття відбитків методом відкритої ложки, попередньо виготовленими індивідуальними ложками з отворами в проекціях імплантатів.

За якістю шинування трансферів, як ключового фактора точності перенесення положення імплантатів, створена шкала оцінювання. Кожна з груп отримувала бали – від 1 до 4. Для підвищення об'єктивності результатів оцінки – критерій 4 отримав коефіцієнт 2.

Група дослідження 1 набрала 6 балів. Завдяки відносно недорогій технології, витрачалося достатньо багато часу на шинування. Пасивність фіксації була найгіршою в порівнянні з іншими методиками та рентгенологічно визначалася найбільша похибка.

Найкращою із обраних методик визначено групу 4 із 17 балами в активі. Незважаючи на дорожівартісність обраної методики, у зв'язку із використанням матеріалу на основі вінілполісілоксану, ортопедичні конструкції, виконані після шинування трансферів цією методикою, володіли найвищою точністю фіксації та рентгенологічно володіли найнижчим показником відхилення аналогів імплантатів на моделі в порівнянні до положення імплантатів в комірковому відростку верхньої щелепи та комірковій частині нижньої щелепи.

Ключові слова: імплантація, відкрита ложка, шинування трансферів.

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СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА МЕТОДИК ШИНУВАННЯ ТРАНСФЕРОВ ПРИ СНЯТТІ ОДНОЕТАПНОГО ДВОХСЛОЙНОГО ОТТИСКА МЕТОДОМ ОТКРЫТОЙ ЛОЖКИ

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Резюме. На VI Консенсусній конференції ІТІ (2018) групою експертів доказано, що найбільш точним методом зняття отисків для виготовлення ортопедичних конструкцій з опорою на імплантати є отиск методом відкритої ложки, знятий поліефірним отискним матеріалом з попередньо проведеним шинуванням трансферів при використанні систем імплантатів з внутрішнім з'єднанням.

Цель исследования: оценка качества переноса положения имплантатов на модель путем сравнительного анализа различных методик клинического шинирования трансферов для снятия оттисков мето-

дом открытой ложки. Исследовано 12 клинических ситуаций. Сформированы 4 группы, согласно проведенной методике шинирования трансферов. Во всех клинических случаях проводилось снятие оттисков методом открытой ложки, предварительно изготовленными индивидуальными ложками с отверстиями в проекциях имплантатов.

Соответственно качеству шинирования трансферов, как ключевого фактора точности переноса положения имплантатов, создана шкала оценивания. Каждая из групп получала баллы – от 1 до 4. Для повышения объективности результатов оценки – критерий 4 получил коэффициент 2.

Группа исследования 1 набрала 6 баллов. Обладая относительно недорогой технологией, тратилось достаточной много времени на шинирование.

Пассивность фиксации была худшей, по сравнению с другими методиками, и рентгенологически определялось наибольшее отклонение.

Лучшей же из избранных методик определена группа 4, с 17 баллами в активе. Несмотря на дорогостоящую выбранную методику, в связи с использованием материала на основе винилполисилоксана, ортопедические конструкции, выполненные после шинирования трансферов по данной методике, владели высокой точностью фиксации, и рентгенологически владели самым низким показателем отклонения аналогов имплантатов на модели по сравнению с положением имплантатов.

Ключевые слова: имплантация, открытая ложка, шинирование трансферов.

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