EVALUATION OF THE ACCURACY BETWEEN SPLINTING AND NON-SPLINTINGIMPRESSION TECHNIQUES FOR MULTIPLE IMPLANTS

Rafael Antônio de **CASTRO**[1], Karen Petená **MORETTI**[1], Renata Pilli **JÓIAS**[2], Patrícia Aparecida da **ANA**[3], Renato Morales **JÓIAS**[4]*

[1] Private Practice Dentist, Brazil.
[2]Department of Orthodontics, Dentistry School, Methodist University of São Paulo, São Bernardo do Campo, SP, Brazil.
[3]Center of Engineering, Modeling, and Applied Social Sciences, Federal University of ABC, Santo André, SP, Brazil.
[4]Department of Prosthodontics, Dentistry School, Methodist University of São Paulo, São Bernardo do Campo, SP, Brazil.

Palavras-chave: Técnica de Moldagem Odontológica. Implantes Dentários. Próteses Dentárias Fixadas por Implante.

RESUMO
Introdução: Entre os fatores determinantes para a longevidade de uma prótese implanto suportada, está o processo exato e meticuloso de moldagem dos implantes osseointegrados, implicando diretamente no assentamento passivo da prótese. **Objetivo:** Comparar a precisão das técnicas de moldagem com e sem união dos transferentes isolando os fatores que podem estar associados ao ajuste passivo. **Métodos:** A partir de um grupo controle composto por um modelo mestre (em resina acrílica quimicamente ativada) mandibular desdentado com quatro implantes de conexão externa posicionados paralelamente e unidos por uma barra metálica. Foram confeccionadas dez moldeiras em resina acrílica quimicamente ativada (todas abertas). Dez impressões foram feitas com silicone de condensação *Xantopren* ®, e vertidas com gesso tipo IV, *Durone* ®, divididas em dois grupos: Grupo 1 (n=5) – Pilares *multi unit* não unidos e Grupo 2 (n=5) – Pilares *multi unit* unidos por uma barra confeccionada com fio dental e resina acrílica autopolimerizável, *Palavit G* ®, através de um molde de silicone de adição, *Elite Double* ® *Zhermack*. Em seguida, a barra foi seccionada e reunida. Os dez modelos de transferência foram mensurados no centro da face vestibular de cada um dos implantes através de uma lupa estereoscópica (*Physis*®) com ampliação de 60 vezes. Os resultados foram tabulados e submetidos à análise estatística não paramétrica, teste *Kruskal-Wallis* (p<0,05). **Resultados:** As médias aritméticas encontradas foram de 22,44 µm (±7) para grupo controle, 26,86 µm (±10) para técnica direta com esplintagem e 24,70 µm (±13) para técnica direta sem esplintagem. **Conclusão:** Não foi identificado diferenças estatísticas significantes entre as técnicas experimentadas.

Keywords: Dental Impression Technique. Dental Implants. Implant-Supported Dental Prosthesis.

ABSTRACT
Introduction: Among the determinant factors for the implant-supported prosthesis longevity is the exact and comprehensive process of impression which results is the passive prosthesis fitting. **Objective:** To compare the accuracy of transfer coping impression techniques with or without splinting, after the isolation of the factors associated to the passive fitting. **Method:** Based on the control group composed by an edentulous mandibular master model (self-cured acrylic resin) with four external hexagon parallel implants splinting with a metallic bar, four customized open trays were constructed with self-cured acrylic. Ten impressions were made with condensation silicone (*Xantopren*®), poured with type IV plaster (*Durone* ®), and then divided into two groups: Group 1 (n=5) – non-splinting *multi unit* transfer copings; and Group 2 (n=5) – splinting *multi unit* transfer copings with a bar constructed with self-cured acrylic resin (*Palavit G* ®) and dental floss, with the aid of an addition silicon mold (*Elite Double* ® *Zhermack)*. Next, the bar was cut and splinted again. The ten transfer molds were measured at the center of the labial surface of each implant with the aid of Stereoscopic Magnifying Glass (*Physis*®) with x60 magnification. The results were tabulated and submitted to non-parametric statistics through *Kruskal-Wallis test* (p<0.05). **Results:** The means were: 22.44 µm (±7) for control group, 26.86 µm (±10) for direct splinting, and 24.70 µm (±13) for direct non-splinting technique. **Conclusion:** No statistically significant differences were found between the tested techniques.

Submitted: May 23, 2018
Modification: August 19, 2018
Accepted: August 31, 2018

*** Correspondence to**:
Renato Morales Jóias
Address: Rua Alfeu Tavares, 149. Edificio Iota, sala 294. Secretaria da Escola de Ciências Médicas e da Saúde. São Bernardo do Campo, São Paulo, Brazil.
Telephone number: +55(11)977776853,
E-mail: renato.joias@metodista.br

INTRODUCTION

Currently, the indication of implant-supported prostheses is partial or total tooth loss because of the success of osseointegration.[1-2] This success relies on the comprehensive prosthetic planning to provide the correct distribution of masticatory forces on the prosthesis.[3-4] The periodontium supports the teeth, while dental implants are functionally ankylosed and in direct contact with bone resulting in lack of mobility and intolerance to movements.[5] The periodontal ligament supports little wrong tooth positions and can move up to 100 µm within the ligament space, thus compensating occlusal maladjustment, horizontal, vertical, and rotational masticatory forces, while an osseointegrated dental implant has extremely limited movements up to 10 µm.[6] Accordingly, the forces over a maladapted prosthesis spread over the superstructure, leading to mechanical and biological failures, as occlusal imbalance, prosthesis fracture, thread fractured, implant fracture, pain, plaque accumulation, marginal bone loss, loosening, and even loss of osseointegration.[1-5,7-10] Although a complete passive adjustment is practically impossible,[2] it is possible to avoid failure by observing the following clinical and laboratorial steps in detail: impression technique, impression tray type, characteristic of the impression material, plaster expansion, parallel or angulated implants, maxilla or mandible, implant connection, transfer coping type, implant and abutment alloy.[3,6,8,11-12] The impression must reproduce the anatomic details precisely and establish the transfer correctly.

Over the years, the literature has reported on the choice for the best impression materials and techniques to achieve the passive adaptation to assure the treatment success. Some studies reported the best impression material,[1-5,7-8,10,12-24] the best technique (direct open tray vs indirect close tray),[5-6,11,15-17,22-24] and the best tray.[2,4,6-7,9,11-12,14,18-22,25-27] However, the literature lacks consensus on the best transfer technique, with or without splitting of transfer copings,[1-21,23,26,28]. By analyzing a systematic review from 1990 to 2012, 30 studies observed the effect of the splinting, 13 (> 43%) found the best splinting technique, and other 13 (> 43%) reported no difference between techniques.[24] Some laboratorial studies concluded that the splinting technique with or without sectioning had small distortion than the non-splinting technique.[4,6,10,18,20,21] On the other hand, other *in vitro* studies point out that either splinting or non-splinting transfer coping techniques are statistically similar.[5,9,12,17,19,26] This study aimed to evaluate transfer coping impression technique with splinting comparing with transfer coping impression technique without splinting, by observing some possible interferences such as: the resin type used for splinting,[1-9,11,13,15,17-19,21,26,29,30] customization of the splinting bar,[14,17] and control of resin polymerization shrinkage.[2,4,6-8,14,17-21,23,27]

MATERIALS AND METHODS

• Master model

Adopting a control group, an edentulous mandibular master model was constructed with chemically-activated acrylic resin (Jet; Artigos Odontológicos Clássico Ltd, São Paulo, Brazil). Four 4x10 mm external hexagonal implants (INP; Sistema de Implantes Nacional e de Próteses Comércio Ltda, São Paulo, Brazil) associated with mult-unit chromium cobalt alloy abutments were placed parallelly on the anterior area.

On the top of the master model, four mult-unit caps (Rotacional C, INP – Sistemas de Implantes Nacional e de Próteses Comércio Ltda, São Paulo, Brazil) were splinted through 1-mm stainless steel orthodontic wire (*Remanium – Sisprodent* Produtos odontológicos), 0.45-mm metallic orthodontic ligatures (Morelli Ortodontia), and acrylic resin (*Dencor Lay*, Artigos Odontológicos Clássico, Ltd). Also, fixture rods were place bilaterally to support the impression tray (Figure 1).

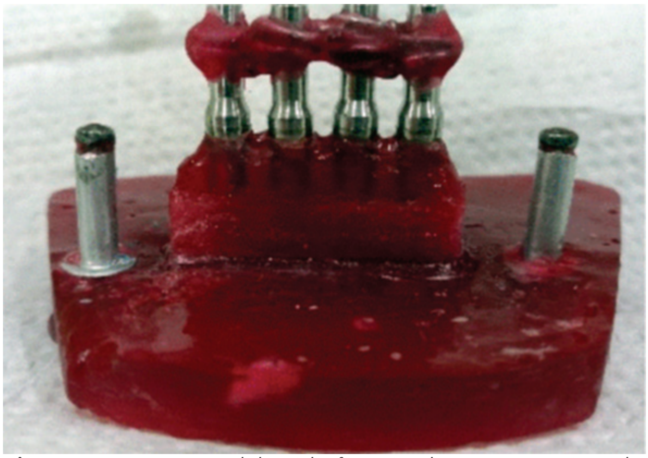

Figure 1: *Master model with four implants supporting the superstructure.*

• Customized trays

After the construction of the master model (control group – C), 5-mm thick condensation silicone (*Optosil® Heraeus Kulzer*) was poured on the implant to assure a uniform thickness of the impression material and a correct placement of the trays during the procedure. Next, two structures were obtained to support the construction of all trays with general dimensions (base, height, width, deepness, and contour) marked with pink wax (n. 7, Lysandra® - Produtos Odontológicos Ltd.). Following, the impression was performed with condensation silicone (*Xantopren®, Heraeus Kulzer*) with catalyzer (*Activator, Heraeus Kulzer*).

Ten 3-mm width open trays were constructed with chemically-activated resin (Jet; Artigos Odontológicos Clássico Ltd, São Paulo, Brazil). These were used to perform all impressions for the studied techniques.

• Samples

<u>Group 1</u> – Transfer coping impression technique without splinting: the *multi-unit* transfer copings were inserted into the implants separately and the threads tightened manually.

<u>Group 2</u> – Transfer coping impression technique with splinting: the four transfer copings were splinted through a standard bar. The components were relieved by wax (PK, Kota ind, SP, Brazil), involved by a n. 7 wax box. Addition silicone (*Elite Double ® Zhermack*) was poured onto this set. After five minutes, the wax relieving was removed, and the customized silicone mold was obtained. Dental floss (Oral B, Sp, Brazil) was used to splint the transfer copings and the acrylic resin (*Palavite G ® Heraeus*) was inserted and guided through nylon technique. After the resin setting, the bar was sectioned with the aid of flexible double-face diamond disc (Discoflex, KG Sorensen, São Paulo, Brazil) by half and laterally between the implants (Figure 2). Then, the bar was splinted again, laterally, with the same acrylic resin. Elapsed five minutes for setting, the bar was splinted in the middle (Figure 3).

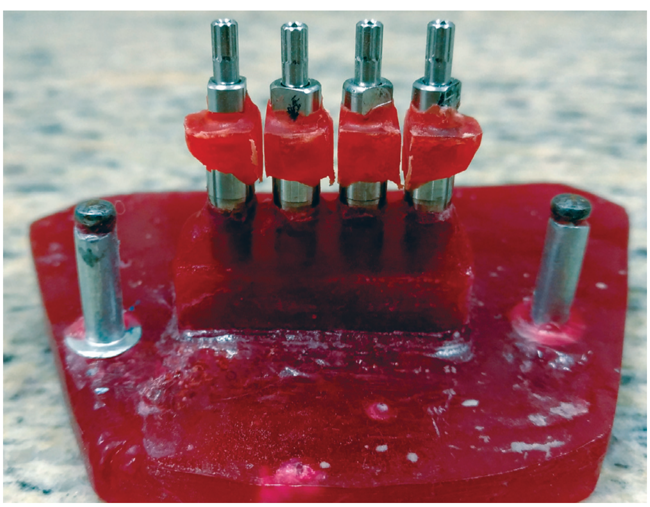

Figure 2: *Splinting bar cut between the implants*

Figure 3: *Re-splinting of the acrylic resin bar.*

Two increments of resin were necessary to splint each 4 sections of the bars. Thus, we obtained five bars with same length, height, and width (27 mm x 4 mm x 6 mm). The operator was previously calibrated by executing 20 increments, attempting to standardize a 3-mm resin amount at every increment. All increments were visually analyzed with the aid of a digital caliper (Leetools, Sp, Brazil).

• Impression technique

All impression trays and the master mold received a layer of universal adhesive (*Zhermack*®, RO, Italy). Elapsed 15 minutes, the condensation silicone (*Xantopren®, Heraeus Kulzer*) with catalyzer (*Activator, Heraeus Kulzer*) was manually mixed according to the manufacturer's instructions on glass plate with the aid of flexible metal spatula. With the aid of a silicone syringe (Polidental, SP, Brazil), the impression material was inserted into the tray placed on the master mold. Elapsed the setting time recommended by the manufacturer, the open-tray threads (*Mult Unit* Digital, Sp, Brazil) were loosened and the impression released. Then, the transfer copings (*Mult Unit* Reto HE 4x4, SP, Brazil) were manually tightened in the proper positions on the impression.

• Working casts

Immediately after the impressions, type IV dental plaster (*Durone*®) was poured. After one-hour setting, the impressions were released. After the working cast cutting, all tested, and control casts received the master superstructure fixed by thread *Mix* (Mult Unit M 1.4x3.5) under 20 Ncm torque on each implant, calibrated with the aid of torque wrench (INP, SP, Brazil). This enabled the evaluation of the passive fitting.

• Scanning procedure

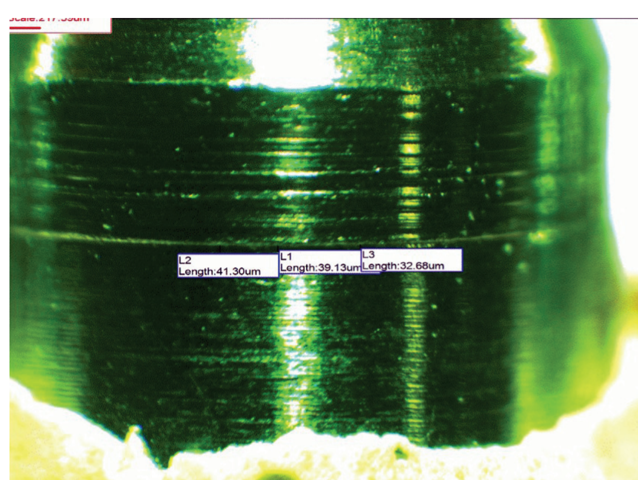

Figure 4: *Measurement of the distance between the implant and the superstructure for one sample.*

After receiving the superstructure, all models (including the master model) were placed on a Stereoscopic Magnifying Glass (*Physis*®) with x60 magnification to analyze the vertical dimensional between each implant and the master superstructure. This analysis started from a landmark on the center of the labial face of the implants. The image of all implant surfaces was scanned by a single operator who identified the beginning and ending of each gap between the implant and the superstructure. Each measurement was performed three times (Figure 4). The values were tabulated totalizing 20 samples for group 1, 20 samples for group 2, and four samples for control group.

• **Statistical analysis**

The statistical analysis was performed through BioEstat 5.0 software. Dixon test evaluated the normal distribution. Data failed the normal distribution and Kruskal-Wallis for independent samples with level of significance of 5% was used.

RESULTS

Table 1 displays the mean and standard deviation of the vertical distances between the implant and superstructure in the master model (C), Transfer coping impression technique without splinting (G1), and Transfer coping impression technique with splinting (G2). No statistically significant differences (p=0.32598) occurred between groups (Kruskal-Wallis for independent samples).

Table 1*: Mean and standard deviation (µm) of the vertical measurements between the implant and superstructure.*

Control	22.44±7.71µm
G1	26.89±10.22µm
G2	26.89±10.22µm

DISCUSSION

The impression of multiple implants by transfer coping is the first step to obtain the passive and accurate prosthesis over osseointegrated implants. The impression goal is to record and transfer the relationship of abutments and implants to the working cast. Thus, the impression has to be a faithful replica of the clinical data of the patient to be transferred to the laboratory, which accounts for the prosthesis construction. Therefore, the dentist should search for the best techniques to assure the exact implant and abutment sites.[3,9,12]

Searching for decreasing the errors in the impression of multiple implants, the literature reports new techniques, such as the direct splinting impression, whose main goal is to link the transfer copings so that no distortion occurs inside the impression.[3,9,16] Currently, different methods are used to splint the copings: acrylic resin with dental floss,[2,6-8,9,17-21] pre-manufactured resin bar,[1,3-4,25] plaster,[11] and composite resin.[2,8] The self-cured acrylic resin is the method of choice.[24] The most used self-cured acrylic resins have been *Pattern Resin* and *Duralay*.[4,7] Although the resin maintains the position of the transfer copings, the resin volume would result in polymerization shrinkage that would lead to distortion. The evaluation of the volumetric shrinkage of self- and light-cured resins showed 5.07% of shrinkage for resin Pattern and 5.72% for resin Duralay, 20 minutes after setting.[30] With that in mind, the literature[2,4,6-8,14,17,19-21,23,27] advise to cut the bar after setting and to splint it again with the same material to prevent shrinkage. Except for two studies,[8,19] the literature (> 83%) reports noteworthy results after the cutting of the splinting bar.

By understanding that the shrinkage value is proportional to the resin amount, this present study standardized the splinting bar thickness with the aid of a silicone mold, which agreed with two previous studies.[14,17] Also, we standardized the number of increments through the nylon technique on the three sectioned areas. Thus, we controlled the resin amount both in the splinting bar constructing and re-splinting.

Based on previous study, we used the self-cured acrylic resin *Palavit G* (®*Heraeus*) because of the volumetric shrinkage lower than (6.5%) that of the acrylic resin *Duralay* (7.9%), after 17 minutes of setting.[9] Some authors reported different setting times for the acrylic resin before and after the cutting of the splinting bar: 17 minutes,[4,7,17,21] 15 minutes,[14] 5 minutes,[23,27] and 4 minutes.[2,8,19] In this study, we waited five minutes for the acrylic resin setting because the ideal impression technique should have some characteristics as: patients' comfort, easiness, accurate impression, and minimum time period.[3]

The use of customized trays show better results than that of conventional trays because of the uniform thickness of the first, which assured a uniform thickness of the impression material.[6] The literature reports sixteen studies using customized trays[1-2,4,6-7,9,11-12,18-22,25,26] and seven using conventional trays.[1,3,5,8,11,13,21] Furthermore, nine studies compared the direct with the indirect technique, and almost unanimously they reported better results with the open tray technique,[6,11-12,15-17,24,27] except for one study that reported no statistically significant differences.[5] Based on this information, this present study used the open tray technique.

Eighteen studies evaluated the accuracy of the Transfer coping impression technique with splinting in angulated and parallel implants. Three studies compared and reported that the indirect technique was the most indicated.[11,21,27] The comparison between the transfer coping impression technique with and without splinting showed best results for the technique with splinting,[3,4,6,13,16-17] except for eight studies (> 44%) that did not find statistically significant differences.[5,7,9,12,17,19,26] By comparing the systematic review of studies from 1990 to 2012, the evidences for the splinting impression technique were inconclusive because 13 studies reported better results, but other 13 (> 43%) did not find statistical differences.[24] The results of this present *in vitro* study agree with the literature.

Only three studies compared the accuracy of the transfer coping impression technique with and without splinting in angulated implants.[6,17,21] In angles higher than 15º, the splinting of the transfer copings reported the best results.[17,24] It is worth noting that this study used a mandible with parallel implants, which agrees with other studies.

This study design was standardized to avoid the factors associated to the impression of implants that may be related to the passive fitting of the definitive prosthesis. The null hypothesis of statistical differences was rejected because no statistically significant differences were found.

The transfer coping impression technique without splinting showed the smallest (10.94 µm) vertical and the greatest (57.24 µm) distance between the implant and the superstructure. The means were: 22.44 µm (±7) for control group (GC), 26.86 µm (±10) for transfer coping impression technique with splinting (G1), and 24.70 µm (±13) for transfer coping impression technique without splinting (G2). Although G2 had the sample with smallest distortion, it had a larger variation than G1 (191.60 µm / 56.04%; 104.62 µm / 38.04% respectively). However, despite of the more unstable results of non-splinting technique compared with more similar and regular results of the splinting technique, no statistically significant differences occurred between groups ($p=0.3598$ $H= 2.0443$, two degrees of freedom).

Considering that the perfectly passive fitting is barely reached, the literature reports an acceptable biological vertical distance between 91 and 150µm.[1,3,5,12,20] The studies evaluating the transfer coping impression technique with and without splinting showed vertical distance means ranging from 32 to 39 µm (control group), 25 to 99 µm (with splinting), and 39 to 205 µm (without splinting).[3,5-7,13,16,17,23] Based on the acceptable vertical distance and the comparison of the means (Table 2), the results of this present study was very satisfactory.

Table 2: *Comparison of the vertical measurement means of this present study (A) with those of the scientific literature (B).* [3,5-7,13,16,17,23]

	(A)	(B)
Control	22.44µm	32 to 39µm
G1	26.89µm	25 to 99µm
G2	24.70µm	39 to 205µm

It can be concluded that no statistically significant differences occurred between the transfer coping techniques with and without splinting for multiple parallel implants. Both techniques had clinically acceptable vertical distances. Both techniques can be used in clinical daily practice, if carefully managed.

ACKNOWLEDGMENTS

We thank to INP (Sistemas de Implantes Nacional e de Próteses Comércio Ltd, São Paulo, Brazil) for providing all the implant and prosthetic components. We thank to HERAEUS KULZER for providing the impression materials.

REFERENCES

1. Gupta S, Narayan AI, Balakrishnan D. In vitro comparative evaluation of different types of Impression trays and impression materials on the accuracy of open tray implant impressions: A pilot study. Int J Dent. 2017 Feb; 2017:8pages.
2. Selvaraj S, Dorairaj J, Mohan J, Simon P. Comparison of implant cast accuracy of multiple implant impression technique with different splinting materials: An in vitro study. J Indian Prosthodont Soc. 2016 Apr-Jun; 16(2):167-75.
3. Avila ED, Moraes FM, Castanharo SM, DelÁlcqua MA, Mollo FAJ. Effect of splinting in accuracy of two implant impression techniques. J Oral Implantol. 2014 Dec; 40(6):633-9.
4. Ghanem RA, Nassani MZ, Baroudi K, Fattah A. Dimensional accuracy of different techniques used for complete-arch multi-implant impressions. J Investig Clin Dent. 2016 Aug; 7(3):225-31.
5.Pera F, Pesce P, Bevilacqua M, Setti P, Menini M. Analysis of different impression techniques and materials on multiple implants through 3-dimensional laser scanner. Implant Dent. 2016 Apr; 25(2):232-7.
6.Shankar QR, Sahoo S, Krishna MH, Kumar OS, Kumar TS, Narula S. Accuracy of implant impressions using various impression techniques and impression materials. J Of Dental Implants. 2016; 6:29-36.
7.Beyabanaki E, Shamshiri AR, Alikhasi M, Monzavi A. Effect of splinting on dimensional accuracy of impressions made of implants with different subgingival alignments. J Prosthodont. 2017 Jan; 26(1):48-55.
8.Di Fiori A, Meneghello R, Savio G, Sivolella S, Katsoulis J, Stellini E. in vitro implant impression accuracy using a new photopolymerizing SDR splinting material. Clin Implant Dent Relat Res. 2015 Oct; 17(2):721-9.
9.Perez-Davidi M, Levit M, Walter O, Eilat Y, Rosenfeld P. Clinical accuracy outcomes of splinted and nonsplinted implant impression methods in dental residency settings. Quintessence Internacional, 2016; 47(10):843-852.
10.Pujari M, Garg P, Prithviraj DR. Evaluation of accuraccy of casts of multiple internal connection implant prosthesis obtained from different impresion materials and techniques: An in vitro study. J Oral Implantol. 2014 Apr; 40(2):137-45.
11.Patil R, Kadam P, Oswal C, Paril S, Jajoo S, Gachake A. A comparative analysis of the accuracy of implant master casts fabricated from two different transfer impression techniques. J Int Soc Prev Community Dent. 2016 Mar-Apr; 6(2):142-8.

12.Papaspyridakos P, Hirayama H, Chen C, Ho C, Chronopoulos V, Weber H. Full-arch implant xed prostheses: a comparative study on the effect of connection type and impression technique on accuracy of t. Clin Oral Implants Res. 2016 Sep; 27(9):1099-105.
13.Avila ED, Barros LAB, Delácqua MA, Castanharo SM, Mollo FAJ. Comparison of the accuracy for three dental impression techniques and index: an in vitro study. J Prosthodont Res. 2013 Oct; 57(4):268-74.
14.Buzayan M, Baig MR; Yunus N. Evaluation of accuracy of complete-arch multiple-unit abutment-level dental implant impressions using different impression and splinting materials. Int J Oral Maxillofac Implants. 2013 Nov-Dec; 28(6):1512-20.
15.Fernandez MA, Mendoza CYP, Platt JÁ, Levon JA, Hovijitra ST, Nimmo A. A comparative study of the accuracy between plastic and metal impression transfer copings for implant restorations. J Prosthodont. 2013 Jul; 22(5):367-76.
16.Stimmelmayar M, Beuer F, Edelhoff D, Guth JG. Implant impression techniques for the edentulous jaw: A summary of three studies. J Prosthodont. 2016 Feb; 25(2):146-50.
17.Tsagkalidis G, Tortopidis D, Mpikos P, Kaisarlis G, Koidis P. Accuracy of 3 different impression techniques for internal connection angulated implants. J Prosthet Dent. 2015 Oct; 114(4):517-23.
18. Faria JCB, Concílio LRS, Neves AC, Miranda E, Teixeira ML. Evaluation of the accuracy of different transfer impression techniques for multiple implants. Braz Oral Res. 2011 Mar-Apr; 25(2):163-7.
19.Faria JCB, Cruz FL, Concílio LRS, Neves AC. Influence of diferente materials and techniques to transfer molding in multiple implants. Acta Odontol latinoam. 2012; 25(1):96-102
20.Al Quran F, Rashdan AB, Abu Zomar AA, Wainer S. Passive fit and accuracy of three dental implant impression techniques. Quintessence International. 2012 Feb; 43(2):119-125.
21.Kurtulmus-yilmaz S, Ozan O, Ozcelik TB, Yagiz A. Digital evaluation of the accuracy of impression techniques and materials in angulated implants. J Dent. 2014 Dec; 42(12):1551-9.
22.Siadat H. Alikhasi M, Beyabanaki E, Rahimian S. Comparison of different impression techniques when using the aII-on-four implant treatment protocol. Int J Prosthodont. 2016 May-Jun; 29(3):265-70.
23.Stimmelmayar M, Erdelt K, Happe A, Sschlee M, Beuer F. Evaluating the discrepancy of two different impression techniques of four implants in an edentulous jaw. In vitro study. Clin Oral Investig. 2013 Nov; 17(8):1929-35.
24.Baig M. Accuracy of impressions of mutiple implants in the edentulous arch: A systematic r eview. Int J Oral Maxillofac Implants. 2014 Jul-Aug;29(4):869-80.
25.Revilla-Leon M, Sánches-Rubio JL, Oteo-Calatayud J, Ozcan M. Impression technique for a complete-arch prothesis with multiple implants using additive manufacturing Technologies. J Prosthet Dent. 2017 Jun; 117(6):714-720.
26.Sabouhi M, Bajoghli F, Abolhasani M. Evaluation of the three-dimensional accuracy of implant impression techniques in two simulated clinical conditions by opticals. Int J Oral Maxillofac Implants. 2015 Jan-Feb; 30(1):26-34.
27.Stimmelmayar M, Guth JF, Erdelt K, Happe A, Schlee M, Beuer F. Clinical study evaluating the discrepancy of two different impression techniques of four implants in an edentulous jaw. Clin Oral Investig. 2013 Nov; 17(8):1929-35.
28.Moreira AH, Rodrigues NF, Pinho AC, Fonseca JC, Vilaça JL. Accuracy comparison of implant impression techniques: A systematic review. Clin Implant Dent Relat Res. 2015 Oct; 17(2):751-64.
29.Mojon P, Oberholzer JP, Meyer JM, Belser UC. Polymerization shrinkage of index and pattern acrylic resins. J Prosthet Dent. 1990 Dec; 64(6):684-8.
30.Gibbs SB, Versluis AV, Tantbirojn D, Ahuja S. Comparison of polymerization shrinkage of pattern resins. College of Dentistry, J Prosthet Dent. 2014 Aug; 112(2):293-8.