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Effectiveness of the full digital flow in the confection of implant-supported single prostheses and comparative analysis between two techniques: with an abutment or direct. Cross-sectional cohort.

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ARTIGO ORIGINAL DE PESQUISA

ABSTRACT

With technological advances in Dentistry, the search for more predictable, integrated, and agile planning and treatments increases. In Implantology, despite the digital flow being greatly encouraged, doubts remain about its technical success. Therefore, the aim of this clinical study was to evaluate the effectiveness of the full digital flow using two techniques for the fabrication of implant prostheses: with an abutment or direct to the implant, comparatively evaluating the time required for interproximal adjustment to adapt the crowns, occlusal adjustment, and the need to return to the laboratory for corrections. The sample consisted of 46 patients who underwent the installation of 75 implants, treated at the ILAPEO School of Dentistry surgical clinic. They were all over 18, of both sexes and received implants in single edentulous spaces that required rehabilitation with crowns. These patients were divided into two groups, with Group I (G1), comprising 27 patients (38 implants) who had received abutments at the time of surgery, and Group II (G2) comprising 28 patients (37 implants) who had received healing caps, with 9 patients in common in both groups. In G1, scan bodies adapted to the abutments were used. In G2, they were directly adapted to the implants. The cases were scanned and sent to the laboratory. When the crowns were installed, the prosthesis adjustment data was recorded (in seconds), as well as the need to return to the laboratory for adjustments and corrections. The data from the groups were compared using the Mann-Whitney non-parametric test. There were no statistical differences in terms of occlusal and proximal adjustment time. The need to return prosthetic work to the laboratory was compared between the groups using the chi-squared test. The GraphPad Prism 8 software (San Diego, CA, USA) was used for the statistical analysis, and all tests were applied at a significance level of 5%. Data analysis leads to the conclusion that digital flow made it possible to obtain satisfactory implant-supported single crowns in both groups. No differences were found between the two techniques regarding the time taken to adapt to the mouth and the need to return to the laboratory.

Keywords: Implant-fixed prosthesis, Intraoral Scanner, CAD/CAM, Dental Implants, Prosthetic Abutments.

Efetividade do fluxo digital completo na confecção de próteses unitárias implantossuportadas e análise comparativa entre duas técnicas: com intermediário ou direta. Coorte transversal.

RESUMO

Com os avanços tecnológicos na Odontologia aumenta a busca por planejamentos e tratamentos mais previsíveis, integrados e ágeis. Na Implantodontia, apesar do fluxo digital estar sendo muito incentivado, permanecem dúvidas quanto ao sucesso técnico. Assim, o objetivo deste estudo clínico foi avaliar a efetividade do uso de fluxo digital completo usando duas técnicas para a confecção de próteses sobre implante: com intermediário ou direta ao implante, avaliando comparativamente o tempo necessário para ajuste interproximal para adaptação das coroas, ajuste oclusal e necessidade de retorno ao laboratório para correções. A amostra foi composta por 46 pacientes submetidos à instalação de 75 implantes, tratados na clínica cirúrgica de Implantodontia da Faculdade ILAPEO, maiores de 18 anos, de ambos os sexos, que receberam implantes em espaços edêntulos unitários e que necessitavam de reabilitação com coroas. Esses pacientes foram divididos em dois grupos, onde o grupo I (GI) foi composto por 27 pacientes (38 implantes) que haviam recebido *abutments* no momento da cirurgia e o outro (GII) com 28 pacientes (37 implantes) que receberam cicatrizadores, havendo 9 pacientes em comum nos dois grupos. No grupo I foram utilizados corpos de escaneamento adaptados aos intermediários e no grupo II adaptados diretamente aos implantes. Os casos foram escaneados e enviados ao laboratório. Na instalação das coroas, os dados de ajustes das próteses foram anotados (em segundos) assim como a necessidade de retorno ao laboratório para ajustes e o aspecto geral das coroas. Os dados foram comparados entre os grupos pelo teste não paramétrico de Mann-Whitney. Foi verificado que não houve diferenças estatísticas em relação ao tempo de ajuste oclusal e proximal. A necessidade de retorno dos trabalhos protéticos ao laboratório foi comparada entre os grupos por meio do teste de quiquadrado. O software GraphPad Prism 8 (San Diego, CA, USA) foi utilizado para análise estatística desse estudo, sendo que todos os testes foram aplicados ao nível de significância de 5%. A análise dos dados permite concluir que a fluxo digital possibilitou a obtenção de coroas unitárias implantossuportadas satisfatórias nos dois grupos, não sendo encontradas diferenças entre as duas técnicas quanto aos tempos para adaptação em boca e necessidades de retornos ao laboratório.

Palavras-chave: Prótese fixa sobre implante, Scanner Intraoral, CAD CAM, Implantes Dentários, Pilares Protéticos.

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INTRODUCTION

Constant technological advances in Dentistry have enabled safer and more integrated planning, more predictable treatments, faster manufacturing processes, more accessible communication between professionals and laboratories, shorter treatment times and fewer appointments, no need for physical space to store plaster models, and greater patient comfort.1-6 These advances cover numerous clinical applications, such as models for case studies and planning, diagnostic wax-ups, surgical guides, and the manufacture of temporary and permanent prostheses.1,4

The CAD/CAM (Computed Aided Design/Computer Aided Manufacturing) system comprises the acquisition of images through intraoral or laboratory scanning (CAI: Computer Aided Imaging), restoration design (CAD), and the manufacturing process (CAM).3,7-9 Such a system was demonstrated in 1989 by Dr. François Duret, in Chicago, with the fabrication of a single crown in just four hours, using an infrared camera to capture structures coated with titanium dioxide powder.1,4,10-12 The technique is constantly evolving and studies13-17 prove the precision and safety of the digital method compared to the analog method and the better adaptation of crowns.18

When making single implant-supported prostheses, there is the possibility of making them on an abutment piece (segmented prostheses) or directly adapted to the implants (non-segmented prostheses). The direct technique has been disseminated as superior and simpler, causing authors and clinicians to use it to the detriment of the first one. Still, there are no studies that prove its efficiency and speed. Because it involves connections and reconnections of components, there are concerns about the effect on peri-implant tissues.

Nevertheless, the technique that uses an abutment, also known as "one abutment-one time", involves installing the component at the time of surgery and attaching it, avoiding removal and replacement during the rehabilitation process. Although there is a systematic review19 that failed to conclude that the one abutment-one time technique produces better results in terms of tissue behavior, there is a report20 that, by including only studies that used internal conical connection implants, presented results that favor this technique.

Baring this in mind, it seems appropriate to conduct a clinical study to assess whether it is possible to make implant-supported single crowns with full digital flow and whether there is a difference between the two techniques (with an abutment or direct), in terms of the time required for occlusal and interproximal adjustment and whether there was a need to return to the laboratory for corrections.

MATERIALS AND METHODS

The project was approved by the Ethics Committee of Sociedade Educacional Herrero under number 3,175,586. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) initiative was used to conduct this cohort study, which aims to compare two ways of rehabilitating single spaces with implant-supported prostheses using full digital flow.

Patients over the age of 18, of both sexes, who were treated at the Implant Dentistry surgical clinic of the ILAPEO School and received Grand Morse® implants (GM, Neodent, Curitiba, Brazil) in single edentulous spaces and who required rehabilitation with single crowns in the maxilla or mandible were invited to take part in this study. Patients who agreed to participate and who signed the Free and Informed Consent Form (Termo de Consentimento Livre e Esclarecido, TCLE) were included.

Excluded from the study analysis were patients who: received implants but refused to sign the TCLE, who could not be submitted to clinical procedures due to limiting health conditions or because they were pregnant, who had a prolonged history of treatment with steroids and bisphosphonates or who had undergone radiotherapy in the last 5 years in the head and neck region that could interfere with bone metabolism, with significant occlusal changes, aggressive or chronic generalized periodontal disease, high tobacco consumption (>10 cigarettes per day), who had bruxism or parafunctional habits and persistent intraoral infection.

The sample was obtained from a search of the ILAPEO School database to check which patients met the inclusion criteria. From this first selection, patients were recruited for an appointment. In this first moment, a periapical X-ray of the area where the implant was installed was obtained and, through the reading of the medical records, the data related to the surgical procedure were verified.

The sample consisted of 75 single cases, 38 of which had received abutments at the time of implant installation (GM universal abutment or GM abutment, Neodent, Curitiba, Brazil) and 37 cases that had not received (instead, they received healing caps).

In this study, 46 patients who underwent installation of 75 implants were evaluated. Patients who received abutments on the day of the surgical procedure were allocated in Group I (G1) and those who received healing caps were placed in Group II (G2), where the prostheses on implants were made on a titanium base or custom titanium blocks.

All patients received the scanning transfer (scanbody, Neodent, Curitiba, Brazil) corresponding to their clinical condition. Intraoral scanning was also carried out using a TRIOS 3 scanner (3shape, Copenhagen, Denmark).

For the G2 patients, the transmucosal height was also measured using a GM height gauge (Neodent, Curitiba, Brazil). The obtained STL file was forwarded to the laboratory (D Lab, Curitiba, Brazil) with the color data sent by photograph. The laboratory was instructed to produce the parts using Ceramill Zolid FX Multilayer blocks (Amann Girrbach AG, Koblach, Austria) with Cerabian ZR (Kuraray Noritake Dental Inc, Nagoya, Japan) and send the parts ready for installation (adapted to the printed model and with components already cemented with Multilink N (Ivoclar Vivadent, Liechtenstein, Germany), if applicable).

At the time of installation, the time required for interproximal adjustment was controlled and recorded. The effectiveness of the contact point was evaluated with dental floss (Johnson`s Reach Essential Mint, Johnson & Johnson, São José dos Campos, Brazil). The time required for occlusal adjustment was also controlled and recorded. Adjustments, when necessary, were minor, just refinements made with aluminum oxide-based stone (Ninja Stone for Zirconia 7703, Talmax, Curitiba, Brazil) and finishing and polishing rubbers for ceramics (sequence of diamond rubbers EVE H2, Odontomega, Ribeirão Preto, Brazil). The necessary repetitions were registered. The installation process was performed by a single operator. The prostheses for G1 patients were cemented with Zinc Phosphate Cement (SS White, São Cristóvão, Brazil). For G2, the screws received the final torque recommended by the manufacturer and the holes were

closed with thread seal tape (Tigre, Joinville, Brazil) and Bioplic temporary restorative (Biodinamika, Ibiporã, Brazil). In the case of the titanium block, after torquing the installation screw, the piece was cemented with Zinc Phosphate Cement (SS White, São Cristóvão, Brazil). A periapical X-ray taken with a radiographic standardizer was obtained at the time of installation of the ceramic crown (Figs 1-5). These data were tabulated and statistical analysis was conducted comparing the results obtained in both groups.

The prosthesis adjustment data was recorded in seconds and subjected to the Kolgomorov-Smirnov normality test, which showed that the data was not normally distributed. These parameters were then compared between the groups using the Mann-Whitney non-parametric test. The need to return prosthetic work to the laboratory was compared between the groups using the chi-squared test. The GraphPad Prism 8 software (San Diego, CA, USA) was used for the statistical analysis. All tests were applied at a significance level of 5%.

RESULTS

The implants were installed in both arches, mostly with Grand Morse connections (Neodent, Curitiba, Brazil) and Acqua surface treatment, with diameters ranging from 3.5mm to 4.3mm and lengths from 5mm to 16mm (Table 1).

Of the 46 patients treated (75 implants) in this study, 27 (38 implants – 50.7%) were treated with the technique that uses abutments and 28 (37 implants – 49.3%) were treated with the direct technique. Nine patients were treated in both groups. Regarding the abutments that were used: 35 prostheses on a GM universal abutment (Neodent, Curitiba, Brazil), 3 on a GM abutment, 33 on a GM titanium base, and 4 on a titanium block.

It was verified that there was no difference between the groups regarding the time of occlusal adjustment and proximal adjustment. The time data required for the adjustments are shown in Graphs 1 and 2 and in Table 2.

Regarding the need to return work to the laboratories, there were no differences between the groups (Table 3).

DISCUSSION

Despite the digital flow being on the rise in dental practice and already being a reality in the clinical routine of professionals21, its efficiency still needs to be proven. In this study, the digital flow proved to be efficient for both groups analyzed, since good models were acquired without the need for repeated scans, with prosthetic crowns ready in the next session and with only minor adjustments required. This is in line with a study that showed the efficiency of the technique, highlighting the use of digital flow for making prostheses on implants22 as a reliable technology.23,24 Although this study did not make comparisons with the analog technique, clinical experience allowed us to conclude that the prostheses returned from the laboratory very close to the ideal, requiring only a few adjustments.

Limitations described for scanners such as the learning curve and the difficulty in obtaining images of subgingival regions, with bleeding and deeper preparations25, were not detected here. As there are scan bodies both at the level of the abutment and at the level of the implants in single implant-supported prostheses, digital flow proved to be very efficient in both techniques.

In terms of material development, lithium disilicate or monolithic zirconia blocks were designed to facilitate the full digital flow. They enable the production of a full implant-supported crown, eliminating the need to apply porcelain afterward and offering high strength. This proposal includes Ceramill Zolid FX Multilayer blocks (Amann Girrbach AG, Koblach, Austria), which is a polychromatic zirconium oxide with a continuous gradient of color and translucency. They also offer color options corresponding to the tones of the VITA classical shade guide (VITA, Bad Säckingen, Germany) and allow pigment adjustments (Cerabian ZR, Kuraray Noritake Dental Inc, Nagoya, Japan). Thus, the crown will exhibit natural translucency characteristics in addition to masking the underlying abutment. Studies suggest that monolithic zirconia has advantages over infrastructures with ceramic toppings.26,27 These findings were confirmed in this study. No grayish surfaces were noticed in any of the cases and all the pieces installed showed promising results.

The time taken to install the prosthetic crowns (including occlusal and proximal adjustments) showed no significant differences between the two groups. Therefore, this

would not be a factor in deciding between the two techniques.

We understand the importance of following up on this study by comparatively evaluating the behavior of the soft and hard tissues of these rehabilitated patients. This can be done by following up with periapical radiographs taken with a positioner that has been standardized and customized for each dental element and through future intraoral scans that will be compared with those taken immediately after the prosthesis has been installed, allowing the assessment of the behavior of the soft tissues. This would grant us the possibility of verifying whether one technique is superior to the other in terms of the biological aspect.

CONCLUSION

Through data analysis, we concluded that the digital flow allowed the attainment of satisfactory implant-supported single crowns in both groups, with no differences found between the two techniques in terms of the time taken to adapt to the mouth and the need to return to the laboratory.

REFERENCES

1. Sotto Maior BS, Filgueiras A, Gonçalves Pinto D, Ferrarez LL, de Oliveira MF, Freitas TA de C. Aplicabilidade clínica dos avanços da tecnologia CAD-CAM em Odontologia. Hu Rev. 2019; 44(1):29-34.

2. Dawood A, Marti BM, Sauret-Jackson V, Darwood A. 3D printing in dentistry. British Dental Jornal. 2015;219(11):521-529.

3. Alghazzawi TF, Advancements in CAD/CAM technology: options for practical implementation. Journal of prosthodontic research. 2016;60(2):72-84.

4. Bósio JA, Del Santo M, Jacob HB. Odontologia digital contemporânea - escâners intraorais digitais. Orthod. Sci. Pract. 2017; 10(39):355-362.

5. Gjelvold B, Chrcanovic BR, Korduner EK, Collin-Bagewitz I. Intraoral digital impression technique compared to conventional impression technique. A randomized clinical trial. Journal of Prosthodontics. 2016;25(4):282-287.

6. Ahmed KE. We're going digital - the current state of CAD/CAM in prosthodontics. Primary Dental Journal. 2018;7(2):30-35.

7. Mizumoto RM, Ylmaz B. Intraoral scan bodies in implant dentistry: a systematic

review. J Prosthet Dent. 2018;120(3):343-352.

8. Joda T, Zarone F, Ferrari M. The complete digital workflow in fixed prosthodontics: a systematic review. BMC Oral Health. 2017;17(124):3-9.

9. Samra APB, Morais E, Mazur RF, Vieira SR, Rached RN. CAD/CAM in dentistry–a critical review. Revista Odonto Ciência. 2016;31(3):140-4.

10. Duret F, Blouin JL, Nahmani L. Functional principles and technical applications of optical impressions in office practice. Cah. Prothese 1985; 13(50):73-110.

11. Logozzo SFG, Kilpelä A, Caponi M, Governi L, Blois L. A Comparative Analysis Of Intraoral 3d Digital Escâners For Restorative Dentistry. The Internet Journal of Medical Technology. 2008; 5(1).

12. Taneva E, Kusnoto B, Evan, CA. 3D Scanning, Imaging, and Printing in Orthodontics. IntechOpen, 2015; 147-88

13. Yuzbasioglu E, Kurt H, Turunc R, Bilir H. Comparison of digital and conventional impression techniques: evaluation of patients' perception, treatment comfort, effectiveness and clinical outcomes. BMC Oral Health. 2014; 14(10).

14. Keeling A, Wu J, Ferrari M. Confounding factors affecting the marginal quality of an intra-oral scan. J Dent. 2017; 59:33-40.

15. Amin S, Weber HP, Finkelman M, El Rafie K, Kudara Y, Papaspyridakos P. Digital vs. conventional full-arch implant impressions: a comparative study. Clin Oral Impl Res 2016;1-8.

16. Richert R, Goujat A, Venet L, Viguie G, Viennot S, Robinson P, Farges JC, Fages M, Ducret M. Intraoral escâner tecnologies: a review to make a sucessful impression. J Healthc Eng. 2017.

17. Burzynski JÁ, Firestone AR, Beck FM, Fields HW Jr, Deguchi T. Comparison of digital intraoral escâners and alginate impressions: Time and patient satisfaction. Am J Orthod Dentofacial Orthop. 2018; 153(4):534-541.

18. Pradíes G, Zarauz C, Valverde A, Ferreiroa A, Martínez-Rus F. Clinical evaluation comparing the fit of all-ceramic crowns obtained from silicone and digital intraoral impressions based on wavefront sampling technology. Journal of dentistry. 2015;43(2):201-208.

19. Atieh MA, Tawse-Smith A, Alsabeeha NHM, Ma S, Duncan WJ. The One Abutment-One Time Protocol: A Systematic Review and Meta-Analysis. J Periodontol. 2017 Nov;88(11):1173-1185.

20. Wang QQ, Dai R, Cao CY, Fang H, Han M, Li QL. One-time versus repeated abutment connection for platform-switched implant: A systematic review and meta-analysis. PLoS One. 2017 Oct 19;12(10):e0186385.

21. Beuer F, Schweiger J, Edelhoff D. Digital dentistry: an overview of recent developments for CAD/CAM generated restorations. Br Dent J. 2008 May 10;204(9):505-11.

22. Traczinski A, Manfrinato JPL, Tassi Junior PA, Sartori IAM. Digital workflow effectiveness: preliminary results. Research, Society and Development, [S. l.], v. 11, n. 8, p. e9911830598, 2022.

23. Berejuk HM, Shimizu RH, Sartori IAM, Valgas L, Tiossi R. Vertical microgap and passivity of fit of three-unit implant-supported frameworks fabricated using different techniques. The International journal of oral & maxillofacial implants, 2014;29(5), 1064-1070.

24. Russo LL, Caradonna G, Biancardino M, De Lillo A, Troiano G, Guida L. Digital versus conventional workflow for the fabrication of multiunit fixed prostheses: A systematic review and meta-analysis of vertical marginal fit in controlled in vitro studies. The Journal of prosthetic dentistry, 2019;122(5), 435-440.

25. Rau CT, Olafsson VG, Delgado AJ, Ritter AV, Donovan TE. The quality of fixed prosthodontic impressions: An assessment of crown and bridge impressions received at commercial laboratories. J Am Dent Assoc. 2017 Sep;148(9):654-660.

26. Stawarczyk B, Keul C, Eichberger M, Figge D, Edelhoff D, Lümkemann N. Three generations of zirconia: from veneered to monolithic. Part I. Quintessence international (Berlin, Germany: 1985), 2017a;48(5), 369-380.

27. Spitznagel FA, Boldt J, Gierthmuehlen PC. CAD/CAM ceramic restorative materials for natural teeth. Journal of dental research, 2018;97(10), 1082- 1091.

FIGURES AND TABLES

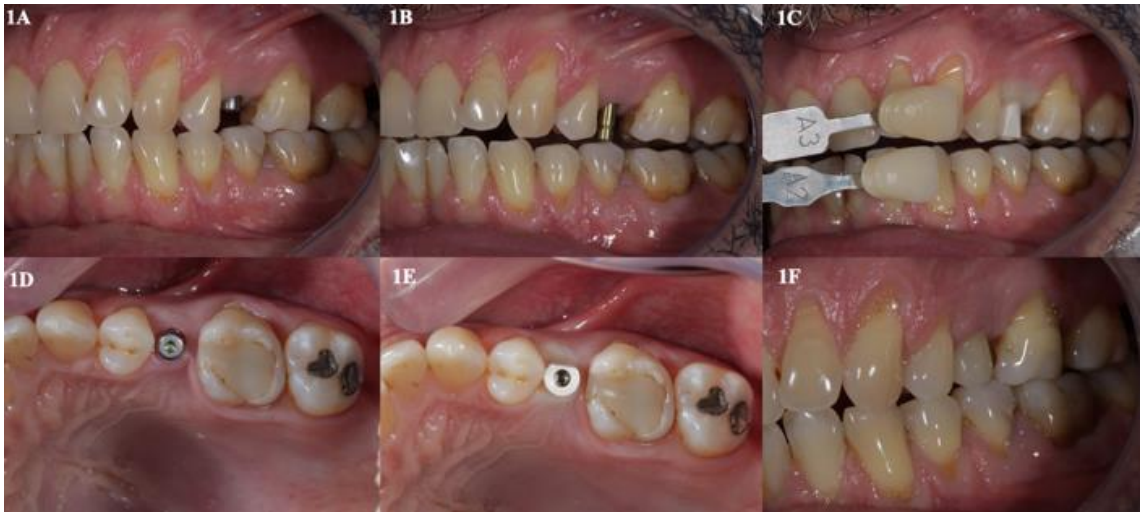


Figure 1A: Lateral view of the healing caps positioned in the 25 region (Group 2). Figure 1B: Test piece from the GM selection kit positioned to select the transmucosal height and diameter of the titanium base. Figure 1C: Scanbody installed for intraoral scanning and shade guide for selection. Figure 1D: Occlusal view of the healing caps in position. Figure 1E: Scanbody installed to capture the position of the implant. Figure 1F: Installed implant prosthesis.

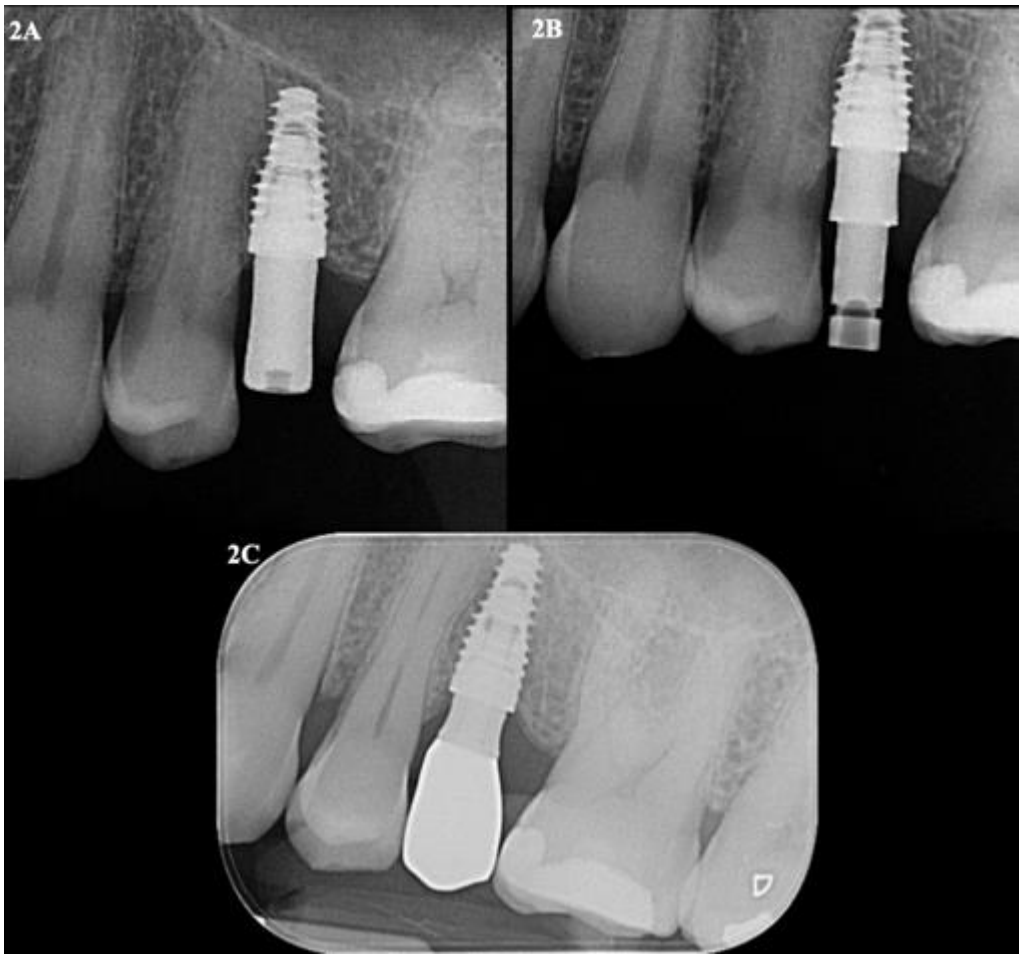


Figure 2A: Periapical X-ray with healing caps over the installed implant. Figure 2B: Periapical X-ray with test piece from the GM selection kit to confirm biological distances measured in the mouth. Figure 2C: Periapical X-ray after installation of the implant prosthesis made on a titanium base.

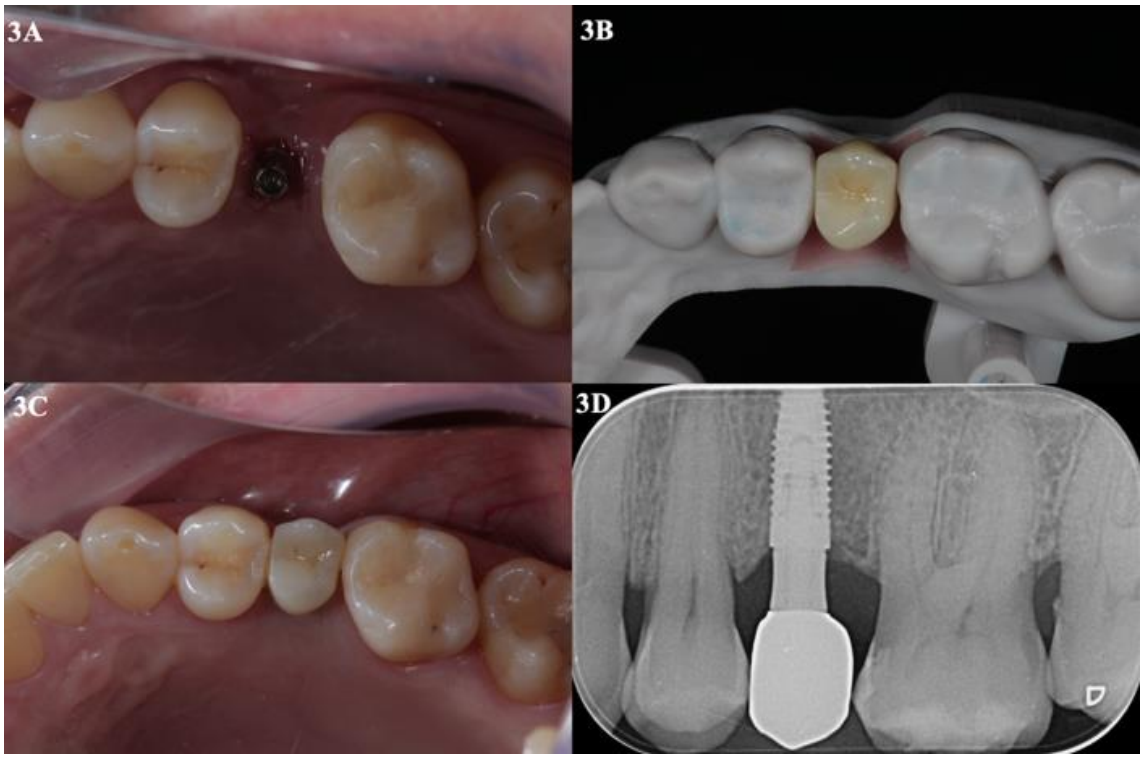


Figure 3A: Occlusal view of the universal abutment after removal of the provisional crown (Group 1). Figure 3B: Implant prosthesis made of polychromatic zirconium oxide on a 3D printed model. Figure 3C: Implant-supported prosthesis cemented on a universal abutment. Figure 3D: Periapical X-ray after the installation of the implant prosthesis in order to check its adaptation to the abutment.

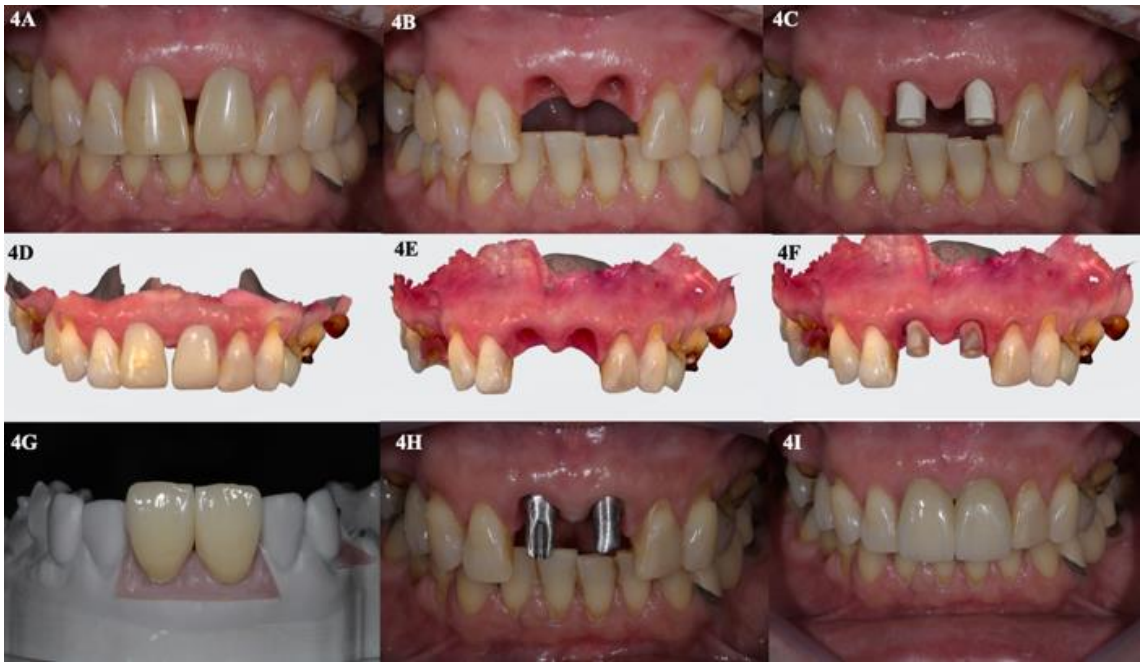


Figure 4A: Intraoral photograph of the provisional prostheses on implants 11 and 21 in position. Figure 4B: Peri-implant profile acquired by the provisionals. Figure 4C: Scanbody in position for intraoral scanning. Figure 4D-F: Images captured through intraoral scanning. Figure 4G: Finished prosthetic pieces adapted on a titanium block (G2) and printed model. Figure 4H: Titanium blocks adapted to the implants. Figure 4I: Intraoral photograph after cementing the prostheses on implants with zinc cement.

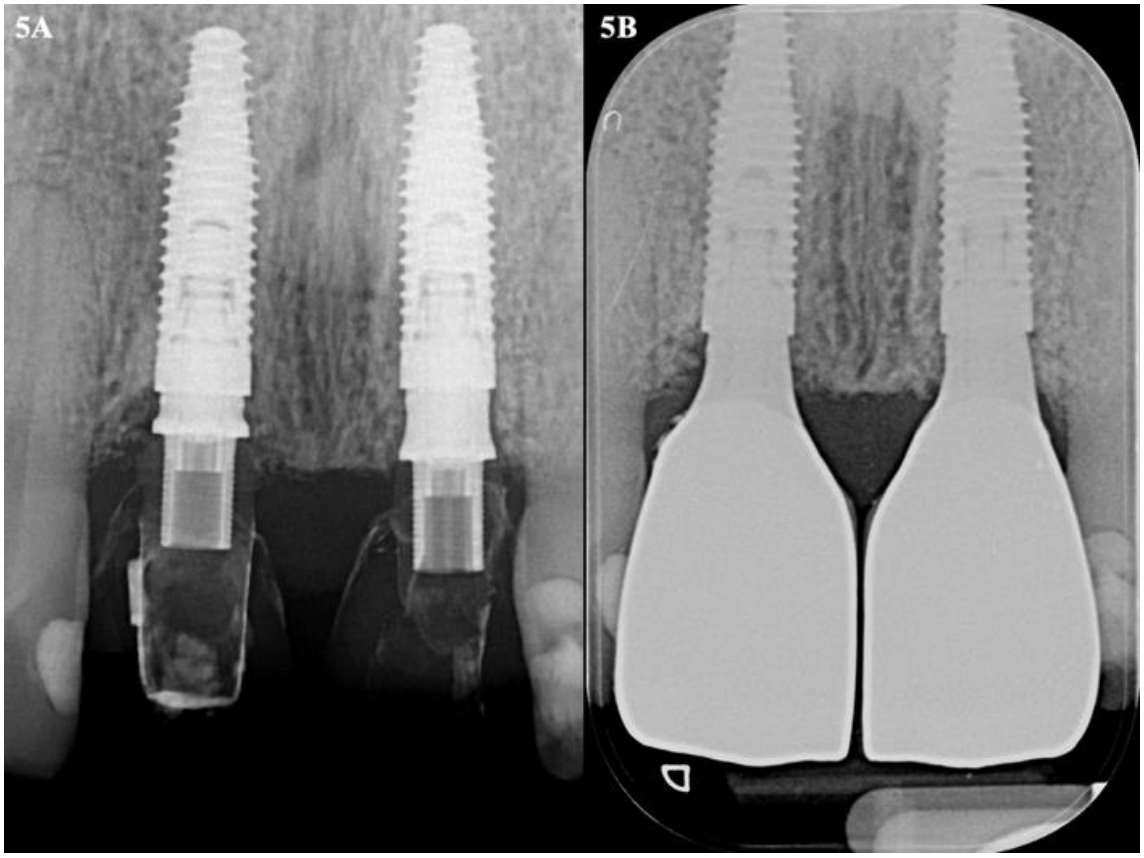
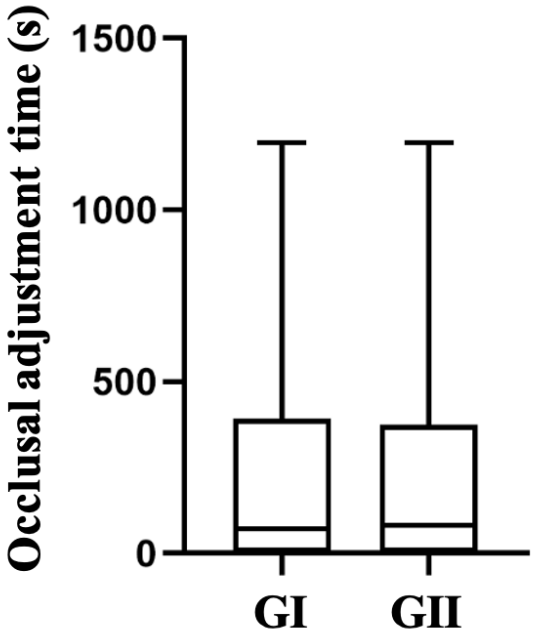


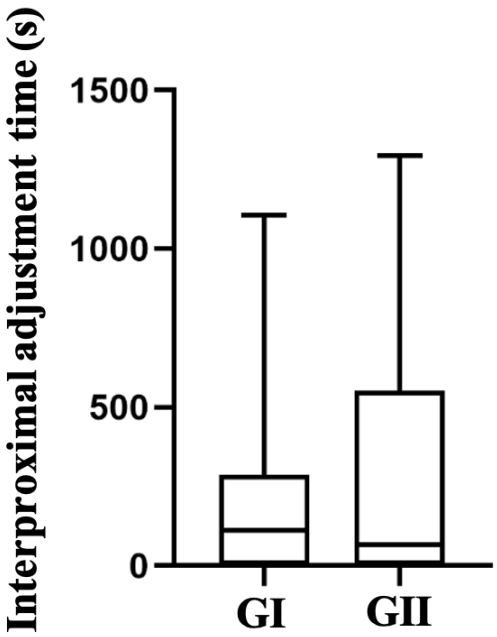
Figure 5A: Initial periapical X-ray of the provisionals over the peek abutment. Figure 5B: Final X-ray after installing the titanium blocks and cementing the crowns onto them.

Dental Arch	Connection type	Surface treatment	Implant diameter	Implant length
Maxilla: 44	GM: 73	Acqua: 73	3.5mm: 15	5mm: 1
Mandible: 31	CM: 1	NeoPoros: 2	3.75mm: 39	7mm: 2
	WS: 1		4mm: 10	8mm: 16
			4.3mm: 11	10mm: 20
				11.5mm: 24
				13mm: 11
				16mm: 1

Table 1: Allocation of implants according to the region where they were installed, type of connection, surface treatment, diameter, and length.



Graph 1: Representation of the distribution of data on the time required for occlusal adjustment in seconds using a box plot showing the median and interquartile ranges of the data obtained in the two evaluation groups.



Graph 2: Representation of the distribution of data on the time required for proximal adjustment in seconds using a box plot showing the median and interquartile ranges of the data obtained in the two evaluation groups.

Time(s) / Group	GI	GII
Occlusal adjustment	72.00(0.00; 393.50)	81.50.00(0.00; 375.30)
Interproximal adjustment	112.00(0.00; 286.5)	65.00(0.00; 551.80)

Table 2: Median data (quartile 1 and quartile 3) of the time required for occlusal and proximal adjustments in seconds in the two evaluation groups.

Return to the laboratory / Group	GI	GII
0	30	21
1	3	4
2	0	1
3	0	2

Table 3: Frequency of prostheses needing to be returned to the laboratory for adjustments.