

A cone-beam computed tomography analysis of the buccal bone wall of immediate implants placement in the esthetic zone of the maxilla: a retrospective cohort study¹

Análise tomográfica de feixe cônico da parede óssea vestibular de implantes imediatos em área estética da maxila: uma coorte retrospectiva

Análisis tomográfico por haz cónico de la pared ósea vestibular de implantes inmediatos en el área estética de la maxila: una cohorte retrospectiva

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ABSTRACT

The objective of this observational clinical study was to analyze the thickness of the buccal bone wall around implants placed immediately with immediate provisionalization in the esthetic region of the maxilla using tomographic imaging. A sample was obtained from a prospective clinical study involving single-unit immediate implant placement and provisionalization and consisted of 17 patients with a mean age of 54.35 (± 13.33) years. A total of 20 implants were placed, with a follow-up period ranging from 1 to 4 years (mean: approximately 3 years); 12 implants were placed in men and 8 in women. Cone-beam computed tomography (CBCT) scans were analyzed using Galileos Implant software to measure the thickness of the buccal bone wall at the level of the implant shoulder and at 2 mm, 4 mm, and 6 mm apical to it. The height of the bone crest relative to the implant shoulder was also evaluated. The mean thickness of the buccal bone wall was 1.92 mm at the level of the implant shoulder. At this same level, the integrity of the buccal bone wall of the extraction socket significantly influenced both bone thickness ($p = 0.002$) and bone crest height ($p = 0.003$), with higher mean values observed when the buccal wall remained intact. Neither the diameter of the implant placed, nor the patient's gingival phenotype influenced buccal bone thickness or bone crest height. Overall, the technique employed promoted the formation of bone-like tissue in an adequate volume on the buccal

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aspect of the implant, and the integrity of the buccal bone wall of the extraction socket was the factor that most strongly influenced the quality of the peri-implant hard tissue.

Keywords: Dental Implants. Immediate Dental Implant Loading. Cone-Beam Computed Tomography.

RESUMO

O objetivo desta pesquisa clínica observacional foi analisar a espessura da parede óssea vestibular de implantes imediatos com provisória imediata na região estética da maxila por meio de medições tomográficas. Foi obtida uma amostra de uma pesquisa clínica prospectiva com implante e provisionalização imediatos unitários, composta por 17 pacientes com idade média de 54,35 ($\pm 13,33$). Foram instalados 20 implantes, com acompanhamento de 1 a 4 anos (tempo médio de 3 anos), sendo 12 instalados em homens e 8 em mulheres. Tomografia computadorizada de feixe cônico (TCFC), o software Galileos Implant foi utilizado para medir a espessura da parede óssea vestibular no nível do ombro do implante e a 2mm, 4mm e 6mm a partir dele. A altura da crista óssea em relação ao ombro do implante também foi avaliada. A espessura média da parede óssea vestibular foi de 1,92mm no nível do ombro do implante, mesmo nível onde a integridade da parede óssea vestibular do alvéolo influenciou a espessura óssea ($p=0,002$) e altura da crista óssea ($p=0,003$), resultando em médias maiores quando intacta. O diâmetro do implante instalado e o fenótipo gengival do paciente não influenciaram na espessura nem na altura da crista óssea. Em uma análise geral, a técnica empregada permitiu formação de tecido semelhante a osso em volume adequado na vestibular do implante e a integridade da parede óssea vestibular do alvéolo foi o que mais influenciou a qualidade do tecido duro peri-implantar.

Palavras-chave: Implantes Dentários. Carga Imediata em Implante Dentário. Tomografia Computadorizada de Feixe Cônico.

RESUMEN

El objetivo de este estudio clínico observacional fue analizar el espesor de la pared ósea vestibular alrededor de implantes colocados de forma inmediata con provisionalización inmediata en la región estética del maxilar mediante imágenes tomográficas. Se obtuvo una muestra procedente de un estudio clínico prospectivo de colocación y provisionalización inmediata de implantes unitarios, compuesta por 17 pacientes con una edad media de 54,35 ($\pm 13,33$) años. Se colocaron un total de 20 implantes, con un período de seguimiento de 1 a 4 años (media: aproximadamente 3 años); 12 implantes fueron colocados en hombres y 8 en mujeres. Las imágenes de tomografía computarizada de haz cónico (TCHC) fueron analizadas mediante el software Galileos Implant para medir el espesor de la pared ósea vestibular a nivel del hombro del implante y a 2 mm, 4 mm y 6 mm en dirección apical a partir de este. También se evaluó la altura de la cresta ósea con respecto al hombro del implante. El espesor medio de la pared ósea vestibular fue de 1,92 mm a nivel del hombro del implante. En este mismo nivel, la integridad de la pared ósea vestibular del alvéolo de extracción influyó significativamente tanto en el espesor óseo ($p = 0,002$) como en la altura de la cresta ósea ($p = 0,003$), observándose valores medios más elevados cuando la pared vestibular se encontraba intacta. Ni el diámetro del implante colocado ni el fenotipo gingival del paciente influyeron en el espesor óseo vestibular ni en la altura de la cresta ósea. En términos generales, la técnica empleada favoreció la formación de tejido similar al hueso en un volumen adecuado en la superficie vestibular del implante, y la integridad de la pared ósea vestibular del alvéolo de extracción fue el factor que más influyó en la calidad del tejido duro periimplantario.

Palabras clave: Implantes Dentales. Carga Inmediata del Implante Dental. Tomografía Computarizada de Haz Cónico.

INTRODUCTION

Immediate implant placement is a safe and predictable technique for rehabilitating teeth indicated for extraction, particularly in esthetic regions (Slagter *et al.*, 2014). However, it does not completely prevent buccal bone remodeling (Araújo *et al.*, 2005; Tan

et al., 2012), recession of the buccal gingival margin, or possible medium- and long-term esthetic complications (Chen; Buser, 2014), which are naturally expected after tooth extraction, as demonstrated in animal studies (Araújo; Lindhe, 2009).

Nevertheless, similar or better esthetic outcomes were found when peri-implant soft tissue was evaluated one year after immediate implant placement with immediate provisionalization, compared with cases restored at a later stage, in the randomized clinical studies by Arora and Ivanovski (2018) and Puisys *et al.* (2022).

The use of cone-beam computed tomography (CBCT) with lip retraction (Januário *et al.*, 2008) enabled more complex analyses of peri-implant tissues, particularly the area buccal to the implant, as well as of factors that may influence treatment success (Degidi *et al.*, 2013; Groenendijk *et al.*, 2020; Zuiderveld *et al.*, 2021; Staas *et al.*, 2022). This type of analysis is considered one of the main tools for evaluating the behavior of hard and soft tissues associated with dental implants (Levine *et al.*, 2022a; 2022b; Groenendijk *et al.*, 2023).

Therefore, the objective of this observational clinical study was to longitudinally analyze the buccal bone wall around immediately placed implants with immediate provisionalization in the esthetic zone of the maxilla using tomographic measurements.

MATERIALS AND METHODS

Study Design and Population

This retrospective cohort with tomographic evaluation included 17 individuals who were treated with immediate placement of 20 dental implants and immediate provisionalization in the esthetic zone of the maxilla between 2018 and 2022, with follow-up ranging from 1 to 4 years (mean follow-up, 3 years) after implant placement. They were systemically healthy, were 27 to 74 years of age, and included both sexes (10 men and 7 women).

The study was approved by the Research Ethics Committee of Veiga de Almeida University, Brazil (CAAE 0069831800005291), and the participants signed an informed consent form in accordance with Brazilian National Health Council Resolution No. 466/2012 (supplemented by Resolution No. 510/2016) of the Ministry of Health.

The following inclusion criteria were applied:

- Immediate implants placed at least 1 year previously in the esthetic zone of the maxilla (up to the second premolar).
- Implant-supported crown with an adequate emergence profile.
- Healthy peri-implant tissue.

The exclusion criteria were:

- Presence of a systemic condition or use of medication that could interfere with bone metabolism.
- Peri-implantitis associated with the implant to be analyzed.
- Smokers of more than 10 cigarettes per day.
- Pregnant or breastfeeding women.

Tomographic Analysis

The tomographic examination was performed to analyze the behavior of peri-implant tissues at the end of the follow-up period.

The CBCT scans were standardized and acquired using an Orthophos SL scanner (Dentsply Sirona, Charlotte, NC, USA), with a 5.0 cm field of view (FOV) and a voxel size of 0.08 mm. Participants used a plastic lip retractor and positioned the tongue toward the posterior portion of the palate, both intended to displace the soft tissues away from the maxillary arch (Januário *et al.*, 2008). The images were analyzed in Galileos Implant software (Dentsply Sirona, Charlotte, NC, USA) by a previously calibrated examiner. Calibration was performed by measuring bone thickness on 10 other images at a 7-day interval, and the intraclass correlation coefficient was greater than 0.99.

The central position of the implant was used as the reference, and the sectional plane was adjusted according to its long axis with the aid of superimposition of a virtual implant template analogous to the implant placed, provided by the software to assist with the linear measurements (Figure 1).

Figure 1 - Tomographic section with virtual implant template

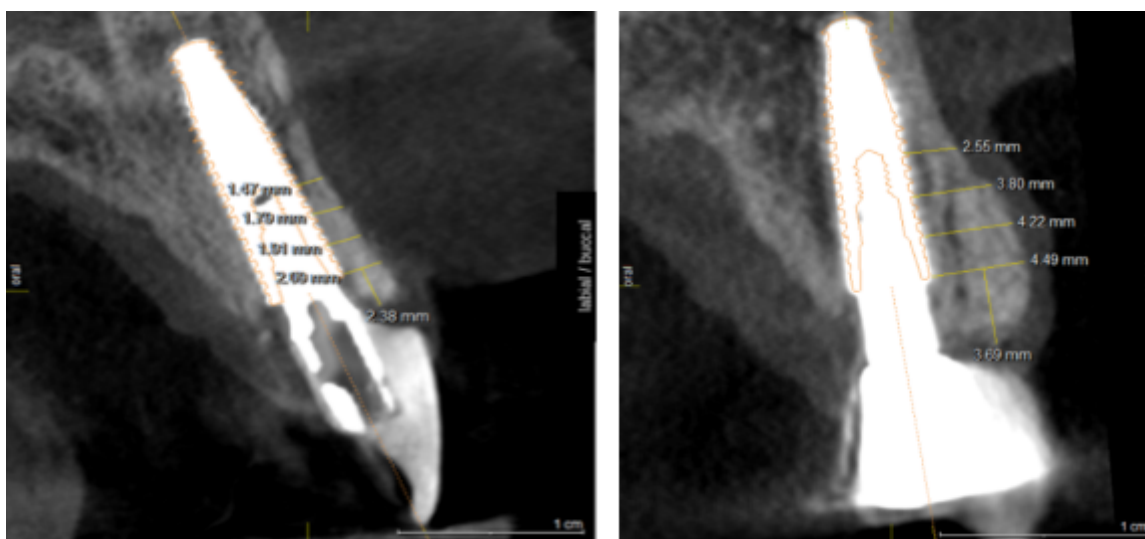


Source: The author, 2024

Buccal bone plate thickness was obtained by a linear measurement, in millimeters, between the external bone surface and the implant surface at the level of the implant shoulder and at 2 mm, 4 mm, and 6 mm from it (Figure 2). If any portion of the implant projected beyond the bony envelope, the measurement was assigned a negative sign, indicating that it was outside the bone.

Buccal bone crest height was obtained by a linear measurement, in millimeters, between the most coronal portion of the bone crest and the implant shoulder (Figure 2). If the bone crest was positioned apical to the implant shoulder, a negative sign was assigned.

Figure 2: Buccal bone measurements



Source: The author, 2024

Collected Data and Previous Procedures

The buccal bone wall of the dental socket (BBW) was evaluated on the CBCT scan obtained before tooth extraction and implant placement. It was considered present when it was intact or showed up to 3 mm of bone loss, and absent when associated bone loss was >3 mm.

The initial gingival phenotype (GP), before implant placement, was determined according to probe transparency through the gingiva after insertion of a millimeter periodontal probe into the gingival sulcus and according to the width of keratinized gingiva, measured as the extent of keratinized tissue between the gingival margin and the mucogingival junction. A thin gingival phenotype was identified when the probe was visible through the gingiva and/or the width of keratinized gingiva was less than 2 mm. In the thick gingival phenotype, the probe shadow was not visible, and the width of keratinized gingiva was greater than 2 mm.

All implants were placed by a single experienced operator immediately after atraumatic, flapless tooth extraction, with a mean subcrestal position of 2 mm relative to the proximal bone crests, following the manufacturer's recommendations. All were Neodent® Helix Grand Morse implants (double taper and internal connection) and were preselected according to the initial tomographic examination. Implant diameters ranged from 3.5 mm to 4.3 mm, and lengths ranged from 11.5 mm to 18 mm. In all cases, the space between the implant and socket was filled with the bone substitute Alobone® (Osseocon, Rio de Janeiro, RJ, Brazil).

A connective tissue graft (CTG) was used in conjunction with implant placement, with the palate as the donor site (harvested using a double-bladed scalpel), in cases in which the width of keratinized gingiva was less than 2 mm or the participant had a high smile line, using the tunneling technique.

All implants received immediate provisional crowns on a universal abutment or titanium base. Patients were instructed to rinse with 0.12% chlorhexidine solution twice daily for 7 days, take amoxicillin 500 mg three times daily for 7 days, and use an analgesic in case of pain.

After 4 months, once the peri-implant soft tissues had been adequately conditioned, treatment proceeded with a definitive porcelain crown. Patients were followed annually for up to 4 years.

Statistical Analysis

A descriptive analysis of the results was performed. Data from the linear bone measurements were analyzed according to variables that could affect the outcome, such as the integrity of the buccal bone wall before implant placement, the use of a connective tissue graft, and the type of initial gingival phenotype, among others.

The data were tested for normality using the Kolmogorov-Smirnov test. Samples with a normal distribution were then analyzed using parametric tests (Student's t test).

Patient and implant characteristics				
Age (years)				
mean (± SD)	54.35 ± 13.33			
	Sex n (%)		Implants n (%)	
Male	10 (59%)		12 (60%)	
Female	7 (41%)		8 (40%)	
	Incisor	Canine	Premolar	Total
Region n	13	1	6	20
Implant length n				
11.5 mm	0	0	3	3
13 mm	3	0	2	5
16 mm	9	1	1	11
18 mm	1	0	0	1
Implant diameter n				
3.5 mm	4	0	1	5
3.75 mm	5	1	2	8
4.3 mm	4	0	3	7

Samples without a normal distribution were analyzed using nonparametric tests (Mann-Whitney U test). Normally distributed samples with three groups were analyzed using ANOVA.

A significance level of 5% and a statistical power of 80% were adopted. Statistical analyses were performed using SPSS, version 25 (IBM Corporation, Armonk, NY, USA).

RESULTS

General data on the patients and implants, as well as their distribution, are presented in Table 1.

Table 1 - General characteristics of patients and implants.

Source: The author, 2024.

Mean bone thickness values at the different implant levels are presented in Table 2. Pairwise comparisons among the thickness measurements showed no statistically significant differences.

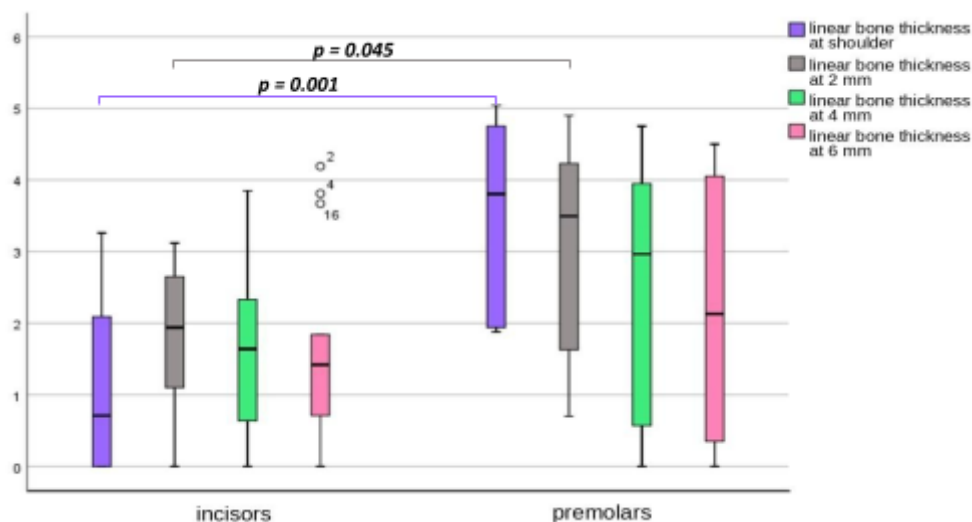
Table 2 - Bone thickness at different implant levels.

	Shoulder	2 mm	4 mm	6 mm		
Mean (± SD)	1.92 (1.67)	2.16 (1.37)	2.05 (1.46)	1.85 (1.47)		
Median	1.91	2.22	1.97	1.48		
	Shoulder - 2 mm	Shoulder - 4 mm	Shoulder - 6 mm	2 mm - 4 mm	2 mm - 6 mm	4 mm - 6 mm
Mean difference	-0.236	-0.128	0.71	0.109	0.308	0.199
P value	0.944	1	1	0.995	0.831	0.504

Source: The author, 2024.

When evaluated according to the regions in which the implants were placed, the premolar group showed greater mean bone thickness than the incisor group at all analyzed levels, with statistically significant differences only at the implant shoulder ($p=0.001$) and at 2 mm ($p=0.045$) (Graph 1).

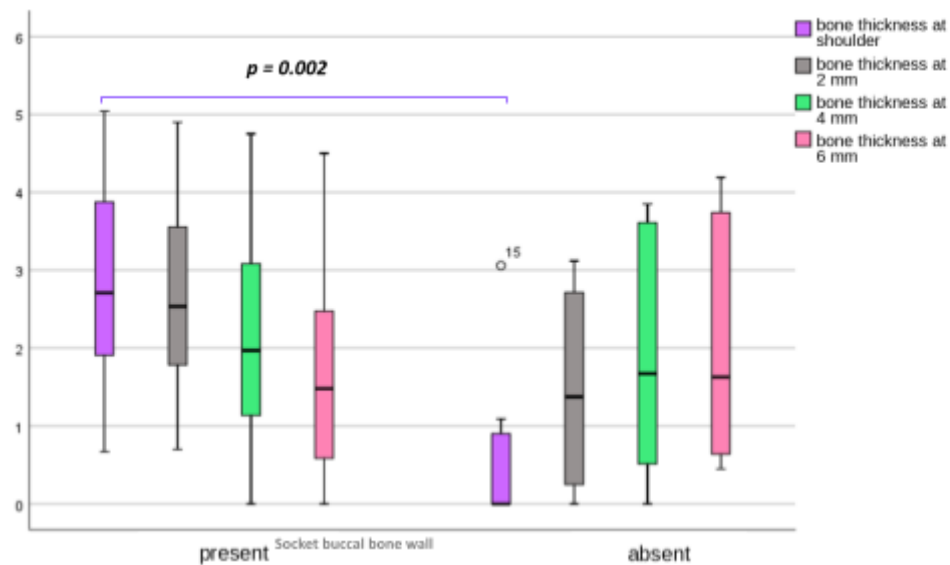
Graph 1: Bone thickness by tooth group at different levels.



Source: The author, 2024

Graph 2 shows the variation in bone thickness measurements after the sample was divided according to the presence or absence of the socket buccal bone wall before implant placement. The presence of the wall influenced bone thickness at the implant shoulder ($p=0.002$).

Graph 2 - Bone thickness according to BBW at different levels.



Source: The author, 2024

When bone thickness was analyzed according to the different implant diameters used, no statistically significant differences in thickness were observed along the implant, although the 3.75 mm diameter implants resulted in greater mean bone thickness values (Table 3).

Table 3 - Bone thickness according to implant diameter at different levels.

Implant diameter	Shoulder	2 mm	4 mm	6 mm
3.5 mm n=5 Mean (± SD)	1.36 (1.25)	1.93 (0.70)	2.11 (1.16)	1.59 (1.33)
3.75 mm n=8 Mean (± SD)	2.35 (1.85)	2.52 (1.54)	2.27 (1.52)	2.04 (1.38)
4.3 mm n=7 Mean (± SD)	1.84 (1.82)	1.90 (1.59)	1.75 (1.73)	1.82 (1.83)
P value	0.602	0.647	0.8	0.879

Source: The author, 2024

The gingival phenotype before implant placement did not influence buccal bone plate thickness along the implant, with no statistically significant difference between thin and thick phenotypes at the analyzed levels. However, greater mean bone thickness values were observed in the thin phenotype (Table 4).

Table 4 - Bone thickness according to GP at different levels.

Gingival phenotype	Shoulder	2 mm	4 mm	6 mm
Thin n=4 Mean ($\pm$ SD)	3.02 (1.44)	3.05 (1.28)	2.76 (1.34)	2.51 (1.38)
Thick n=16 Mean ($\pm$ SD)	1.65 (1.65)	1.93 (1.33)	1.87 (1.48)	1.68 (1.49)
P value	0.178	0.249	0.249	0.211

Source: The author, 2024

Analysis of the linear measurement from the implant shoulder to the buccal bone crest showed a difference between the group with an intact buccal bone wall, with a mean height of 2.19 mm, and the group with a defect ($p=0.003$). The different implant diameters did not influence bone crest height or bone formation, nor did the different gingival phenotypes (Table 5).

Table 5 - Bone crest height relative to the implant shoulder.

	n	Mean ($\pm$ SD)	P value
Buccal bone wall			
Present	12	2.19 (1.20)	0.003
Absent	8	-0.35 (2.07)	
Implant diameter (mm)			
3.5	5	0.84 (1.34)	0.922
3.75	8	1.24 (2.37)	
4.3	7	1.32 (2.21)	
Gingival phenotype			
Thin	4	1.64 (0.95)	0.892
Thick	16	1.05 (2.21)	

Source: The author, 2024.

DISCUSSION

The stability of peri-implant tissues around immediately placed implants is a concern for many researchers. In this study, we found mean bone thickness values similar to those reported in previous studies using comparable methodologies that analyzed both sockets with an intact buccal bone wall and sites with defects, with and without connective

tissue grafting (Cosyn *et al.*, 2016; Buser *et al.*, 2017; Groenendijk *et al.*, 2020; Lee *et al.*, 2020; Zuiderveld *et al.*, 2021; Levine *et al.*, 2022; Qian *et al.*, 2023).

The mean bone thickness values found are consistent with those of similar studies. At the implant shoulder in particular, this study found a mean thickness of 1.92 mm, close to the 2.12 mm reported by Degidi *et al.* (2013), 1.7 mm by Levine *et al.* (2022), and 2.4 mm by Staas *et al.* (2022).

The difference in bone thickness at the implant shoulder and at 2 mm between the tooth groups may be related to the inclusion of different maxillary regions in the sample, in which the extracted teeth had different root anatomies as well as distinct bone characteristics. Premolar regions have sockets with a greater buccolingual dimension than incisor regions, which consequently favors a larger horizontal gap between the implant and the buccal bone wall during placement, resulting in greater bone thickness (Ferrus *et al.*, 2010).

The different implant diameters used did not influence buccal bone thickness or bone crest height, as also reported in the study by Levine *et al.* (2022). This may be explained by the fact that implant diameter was selected considering the cervical diameter of the tooth to be restored and, especially, the socket diameter, to ensure a space of at least 2.0 mm between the implant and the inner surface of the buccal bone wall. Regarding vertical positioning, the objective was to provide a distance of 3.0 to 4.0 mm from the gingival margin (Morton *et al.*, 2014).

Bone thickness at the implant shoulder was influenced by the integrity of the buccal bone wall, with a mean of 2.8 mm in the group with the wall present and 0.6 mm in the group with a defect. Qian *et al.* (2023) found a mean bone thickness of 2.01 mm at the implant shoulder in a sample with a mean buccal bone plate defect of 5.08 mm, differing from the results of the present study. This divergence between studies may be related to the surgical approach and to the use of a bone substitute with a collagen membrane and connective tissue grafting in all cases treated by Qian *et al.* (2023). In a systematic review, Seyssens, De Lat and Cosyn (2021) highlighted the relevance of connective tissue grafting in situations at risk of tissue recession, such as cases with bone thickness below 0.5 mm, with the aim of improving peri-implant tissue stability.

The same pattern was observed for bone crest height, in which pre-existing defects resulted in a negative mean (-0.35 mm), indicating that, in some cases, the bone crest was apical to the implant shoulder and suggesting that bone formation had not occurred. Pohl *et*

al. (2020) also observed similar behavior but found no difference between groups with and without a buccal wall in a pilot study without any type of graft. In similar studies that used the integrity of the socket buccal bone wall as a criterion, mean values of 2.21 mm were reported by Degidi *et al.* (2013) and 0.3 mm by Levine *et al.* (2022), whereas the mean in the present study under the same condition was 2.19 mm.

Gingival phenotype did not affect the bone measurements; however, in a clinical study, Zuiderveld *et al.* (2021) demonstrated that phenotype influenced changes in bone thickness after 1 year. The sample size may have contributed to the lack of a statistically significant difference in the present study. In addition, connective tissue grafting was selectively indicated in patients with a thin phenotype and a high smile line, based on studies with similar characteristics by Levine *et al.* (2022a) and Araújo *et al.* (2026).

The main limitations of this sample include its still limited size, which increases the probability of a Type II error in subgroup analyses. Follow-up ranged from 1 to 4 years (mean, 3 years), requiring caution when generalizing tissue behavior to longer periods. Tomographic evaluation was concentrated at the end of the follow-up period, precluding a paired linear comparison with an immediate postoperative examination. CBCT measurements assess the thickness of the buccal radiopaque image, which includes both native/remodeled bone tissue and integrated particles of the bone substitute used.

FINAL CONSIDERATIONS

Overall, the technique allowed volumetric maintenance/stability of the radiopaque buccal contour produced by the implant-biomaterial complex. The integrity of the socket buccal bone wall was the factor that most strongly influenced the quality of the peri-implant tissues.

REFERENCES

ARAÚJO, M. G.; SUKEKAVA, F.; WENNSTRÖM, J. L.; LINDHE, J. Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. **Journal of Clinical Periodontology**, v. 32, n. 6, p. 645-652, Jun. 2005. Available at: <https://doi.org/10.1111/j.1600-051X.2005.00726.x>. Accessed on: 13 Oct. 2026.

ARAÚJO, M. G.; LINDHE, J. Ridge alterations following tooth extraction with and without flap elevation: an experimental study in the dog. **Clinical Oral Implants Research**, v. 20, n. 6, p. 545-549, Jun. 2009. Available at: <https://doi.org/10.1111/j.1600-0501.2008.01703.x>. Accessed on: 13 Oct. 2026.

ARAÚJO, M. G.; DIAS, D. R.; WANG, P.; LEVINE, R. A. Effect of the Buccal Gap Width on Alveolar Process Reduction Following Immediate Implant Placement: A Retrospective CBCT Study. **Clinical Oral Implants Research**, v. 37, n. 5, p. 630-642, May 2026. Available at: <https://doi.org/10.1111/clr.70106>. Accessed on: 13 Oct. 2026.

ARORA, H.; IVANOVSKI, S. Clinical and aesthetic outcomes of immediately placed single-tooth implants with immediate vs. delayed restoration in the anterior maxilla: A retrospective cohort study. **Clinical Oral Implants Research**, v. 29, n. 3, p. 346-352, Mar. 2018. Available at: <https://doi.org/10.1111/clr.13125>. Accessed on: 13 Oct. 2026.

BUSER, D.; CHAPPUIS, V.; BELSER, U. C.; CHEN, S. Implant placement post extraction in esthetic single tooth sites: when immediate, when early, when late? **Periodontology** 2000, v. 73, n. 1, p. 84-102, Feb. 2017. Available at: <https://doi.org/10.1111/prd.12170>. Accessed on: 13 Oct. 2026.

CHEN, S. T.; BUSER, D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla-a systematic review. **International Journal of Oral & Maxillofacial Implants**, v. 29, supl., p. 186-215, 2014. Available at: <https://doi.org/10.11607/jomi.2014suppl.g3.3>. Accessed on: 13 Oct. 2026.

COSYN, J.; EGHBALI, A.; HERMANS, A.; VERVAEKE, S.; DE BRUYN, H.; CLEYMAET, R. A 5-year prospective study on single immediate implants in the aesthetic zone. **Journal of Clinical Periodontology**, v. 43, n. 8, p. 702-709, Aug. 2016. Available at: <https://doi.org/10.1111/jcpe.12571>. Accessed on: 13 Oct. 2026.

DEGIDI, M.; DAPRILE, G.; NARDI, D.; PIATTELLI, A. Buccal bone plate in immediately placed and restored implant with Bio-Oss (®) collagen graft: a 1-year follow-up study. **Clinical Oral Implants Research**, v. 24, n. 11, p. 1201-1205, Nov. 2013. Available at: <https://doi.org/10.1111/j.1600-0501.2012.02561.x>. Accessed on: 13 Oct. 2026.

FERRUS, J.; CECCHINATO, D.; PJETURSSON, E. B.; LANG, N. P.; SANZ, M.; LINDHE, J. Factors influencing ridge alterations following immediate implant placement into extraction sockets. **Clinical Oral Implants Research**, v. 21, n. 1, p. 22-29, Jan. 2010. Available at: <https://doi.org/10.1111/j.1600-0501.2009.01825.x>. Accessed on: 13 Oct. 2026.

GROENENDIJK, E.; STAAS, T. A.; BRONKHORST, E.; RAGHOEBAR, G. M.; MEIJER, G. J. Immediate implant placement and provisionalization: Aesthetic outcome 1 year after implant placement. A prospective clinical multicenter study. **Clinical Implant Dentistry and Related Research**, v. 22, n. 2, p. 193-200, Apr. 2020. Available at: <https://doi.org/10.1111/cid.12883>. Accessed on: 13 Oct. 2026.

GROENENDIJK, E.; STAAS, T. A.; BRONKHORST, E. M.; RAGHOEBAR, G. M.; MEIJER, G. J. Factors Associated with Esthetic Outcomes of Flapless Immediate Placed and Loaded Implants in the Maxillary Incisor Region-Three-Year Results of a Prospective Case Series. **Journal of Clinical Medicine**, v. 12, n. 7, Mar. 2023. Available at: <https://doi.org/10.3390/jcm12072625>. Accessed on: 13 Oct. 2026.

JANUÁRIO, A. L.; BARRIVIERA, M.; DUARTE, W. R. Soft tissue cone-beam computed tomography: a novel method for the measurement of gingival tissue and the dimensions of the dentogingival unit. **Journal of Esthetic and Restorative Dentistry**, v. 20, n. 6, p. 366-373, 2008. Available at: <https://doi.org/10.1111/j.1708-8240.2008.00210.x>. Accessed on: 13 Oct. 2026.

LEE, C.-T.; SANZ-MIRALLES, E.; ZHU, L.; GLICK, J.; HEATH, A.; STOUPEL, J. Predicting bone and soft tissue alterations of immediate implant sites in the esthetic zone using clinical parameters. **Clinical Implant Dentistry and Related Research**, v. 22, n. 3, p. 325-332, Jun. 2020. Available at: <https://doi.org/10.1111/cid.12910>. Accessed on: 13 Oct. 2026.

LEVINE, R. A.; DIAS, D. R.; WANG, P.; ARAÚJO, M. G. Effect of Connective Tissue Graft Following Immediate Implant Placement on Esthetic Outcomes at Maxillary Central Incisor Sites: A Long-Term Cohort Study. **International Journal of Periodontics & Restorative Dentistry**, v. 42, n. 5, p. e143-e151, Sep.-Oct. 2022a. Available at: <https://doi.org/10.11607/prd.5773>. Accessed on: 13 Oct. 2026.

LEVINE, R. A.; DIAS, D. R.; WANG, P.; ARAÚJO, M. G. Effect of the buccal gap width following immediate implant placement on the buccal bone wall: A retrospective cone-beam computed tomography analysis. **Clinical Implant Dentistry and Related Research**, v. 24, n. 4, p. 403-413, Aug. 2022b. Available at: <https://doi.org/10.1111/cid.13095>. Accessed on: 13 Oct. 2026.

MORTON, D.; CHEN, S. T.; MARTIN, W. C.; LEVINE, R. A.; BUSER, D. Consensus statements and recommended clinical procedures regarding optimizing esthetic outcomes in implant dentistry. **International Journal of Oral & Maxillofacial Implants**, v. 29, suppl., p. 216-220, 2014. Available at: <https://doi.org/10.11607/jomi.2013.g3>. Accessed on: 13 Oct. 2026.

POHL, V.; FÜRHAUSER, L.; HAAS, R.; POHL, S. Gingival recession behavior with immediate implant placement in the anterior maxilla with buccal dehiscence without additional augmentation-a pilot study. **Clinical Oral Investigations**, v. 24, n. 4, p. 1455-1464, Apr. 2020. Available at: <https://doi.org/10.1007/s00784-019-03176-5>. Accessed on: 13 Oct. 2026.

PUISYS, A.; AUZBIKAVICIUTE, V.; VINDASIUTE-NARBUTE, E.; PRANSKUNAS, M.; RAZUKEVICUS, D.; LINKEVICIUS, T. Immediate implant placement vs. early implant treatment in the esthetic area. A 1-year randomized clinical trial. **Clinical Oral Implants Research**, v. 33, n. 6, p. 634-655, Jun. 2022. Available at: <https://doi.org/10.1111/clr.13924>. Accessed on: 13 Oct. 2026.

QIAN, S.-J.; PU, Y.-P.; ZHANG, X.-M.; WU, X.-Y.; LIU, B.-L.; LAI, H.-C.; SHI, J.-Y. Clinical, radiographic, and esthetic evaluation of immediate implant placement with buccal bone dehiscence in the anterior maxilla: A 1-year prospective case series. **Clinical Implant Dentistry and Related Research**, v. 25, n. 1, p. 3-10, Feb. 2023. Available at: <https://doi.org/10.1111/cid.13154>. Accessed on: 13 Oct. 2026.

SEYSSSENS, L.; DE LAT, L.; COSYN, J. Immediate implant placement with or without connective tissue graft: A systematic review and meta-analysis. **Journal of Clinical Periodontology**, v. 48, n. 2, p. 284-301, Feb. 2021. Available at: <https://doi.org/10.1111/jcpe.13397>. Accessed on: 13 Oct. 2026.

SLAGTER, K. W.; DEN HARTOG, L.; BAKKER, N. A.; VISSINK, A.; MEIJER, H. J.; RAGHOEBAR, G. M. Immediate placement of dental implants in the esthetic zone: A systematic review and pooled analysis. **Journal of Periodontology**, v. 85, n. 7, p. e241-e250, Jul. 2014. Available at: <https://doi.org/10.1902/jop.2014.130632>. Accessed on: 13 Oct. 2026.

STAAS, T. A.; GROENENDIJK, E.; BRONKHORST, E.; VERHAMME, L.; RAGHOEBAR, G. M.; MEIJER, G. J. Does initial buccal crest thickness affect final buccal crest thickness after flapless immediate implant placement and provisionalization: A prospective cone beam computed tomogram cohort study. **Clinical Implant Dentistry and Related Research**, v. 24, n. 1, p. 24-33, Feb. 2022. Available at: <https://doi.org/10.1111/cid.13060>. Accessed on: 13 Oct. 2026.

TAN, W. L.; WONG, T. L.; WONG, M. C.; LANG, N. P. A systematic review of post-extractional alveolar hard and soft tissue dimensional changes in humans. **Clinical Oral Implants Research**, v. 23, supl. 5, p. 1-21, Feb. 2012. Available at: <https://doi.org/10.1111/j.1600-0501.2011.02375.x>. Accessed on: 13 Oct. 2026.

ZUIDERVELD, E. G.; VAN NIMWEGEN, W. G.; MEIJER, H. J. A.; JUNG, R. E.; MÜHLEMANN, S.; VISSINK, A.; RAGHOEBAR, G. M. Effect of connective tissue grafting on buccal bone changes based on cone beam computed tomography scans in the esthetic zone of single immediate implants: A 1-year randomized controlled trial. **Journal of Periodontology**, v. 92, n. 4, p. 553-561, Apr. 2021. Available at: <https://doi.org/10.1002/JPER.20-0217>. Accessed on: 13 Oct. 2026.

