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ORAL REHABILITATION WITH EXTRA-NARROW OSSEOINTEGRATED IMPLANTS IN A YOUNG PATIENT WITH AGENESIS OF THE UPPER LATERAL INCISORS: CASE REPORT WITH 19-MONTH FOLLOW-UP

REABILITAÇÃO ORAL COM IMPLANTES OSSEOINTEGRADOS EXTRA-ESTREITOS EM PACIENTE JOVEM COM AGENESIA DOS INCISIVOS LATERAIS SUPERIORES: RELATO DE CASO COM ACOMPANHAMENTO DE 19 MESES

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ABSTRACT

Current osseointegrated implants have high success rates in rehabilitative treatments, even in challenging cases, thanks to advances in computed tomography, virtual planning, surgical techniques, biomaterials, and implant macrogeometry. This study aimed to report a clinical case of upper lateral incisor rehabilitation with extra-narrow implants using guided surgery with the hybrid technique. An 18-year-old patient with agenesis of the upper lateral incisors, previously treated with temporary implants, underwent scanning of the upper arch for virtual planning and surgical guide fabrication. After explantation of the temporary implants, two extra-narrow implants (Ø 2.9 mm) were installed, followed by temporary restoration. After six months, Variobase® prosthetic abutments and zirconia crowns were installed. The patient was satisfied with the esthetic and functional results. Clinical and radiographic follow-up for 19 months showed adequate peri-implant bone and gingival maintenance. The proper three-dimensional positioning of the implants proved to be fundamental for the preservation of the crestal bone and the formation of papillae. It is concluded that extra-narrow implants are an effective and predictable alternative for the rehabilitation of areas with reduced mesiodistal space and low masticatory demand, especially in the replacement of upper lateral incisors and lower incisors.

Keywords: Dental Implants; Anodontia; Planning; Dental Prosthesis

RESUMO

Os implantes osseointegrados atuais apresentam altas taxas de sucesso em tratamentos de reabilitação, mesmo em casos desafiadores, graças aos avanços em tomografia computadorizada, planejamento virtual, técnicas cirúrgicas, biomateriais e macrogeometria dos implantes. Este estudo teve como objetivo relatar um caso clínico de reabilitação dos incisivos laterais superiores com implantes extra-estreitos utilizando cirurgia guiada com a técnica híbrida. Uma paciente de 18 anos com agenesia dos incisivos laterais superiores, previamente tratada com implantes provisórios, foi submetida à tomografia computadorizada da arcada superior para planejamento virtual e confecção do guia cirúrgico. Após a explantação dos implantes provisórios, dois implantes extra-estreitos (Ø 2,9 mm) foram instalados, seguidos de restauração provisória. Após seis meses, foram instalados pilares protéticos Variobase® e coroas de zircônia. A paciente ficou satisfeita com os resultados estéticos e funcionais. O acompanhamento clínico e radiográfico por 19 meses demonstrou manutenção adequada do osso peri-implantar e da gengiva. O correto posicionamento tridimensional dos implantes mostrou-se fundamental para a preservação do osso alveolar e a formação das papilas. Conclui-se que implantes extra-estreitos são uma alternativa eficaz e previsível para a reabilitação de áreas com espaço mesiodistal reduzido e baixa demanda mastigatória, especialmente na substituição de incisivos laterais superiores e inferiores.

Palavras-chave: Implantes dentários; Anodontia; Planejamento; Prótese dentária

INTRODUCTION AND LITERATURE REVIEW

Oral rehabilitation with osseointegrated implants is a treatment with a high success rate (Smith Nobrega et al., 2016; Gupta et al., 2021) and has become increasingly predictable due to advances in surgical techniques (Smitkarn et al., 2019), improvements in implant macrogeometry (Heimes et al., 2023), high-quality complementary exams such as cone beam computed tomography (Jacobs et al., 2018), use of biomaterials (Goyal et al., 2021; Win, Pimkhaokham, and Kaboosaya., 2024), and planning (Esquivel, Meda, and Blantz, 2021). Planning, whether analog or digital, is a crucial step for the success of treatment with osseointegrated implants. At this stage, the region to be rehabilitated, its characteristics and limitations, the surrounding noble structures, and the quality of the peri-implant tissue are identified, ensuring lower rates of trans- and post-operative complications (Ganz, 2015; Esquivel, Meda, and Blantz, 2021). It has become an essential tool that facilitates the work of dental surgeons, whether they are experienced or beginners in the field of implant dentistry. Ideal three-dimensional (3D) positioning of implants is certainly preceded by good planning.

With the advent of virtual planning and guided surgery, considering mesiodistal, vestibulopalatal, and apicocoronal positioning, results very similar or identical to those expected are obtained (Smitkarn et al., 2019; Chen and Nikoyan, 2020), ensuring greater treatment longevity. The anterior region presents major aesthetic challenges, with guided surgery and virtual planning being important steps for achieving success. Faced with such anatomical limitations, companies have sought solutions and improvements through alternative implant systems, which aim to reduce the need for a large number of surgical procedures and, consequently, decrease patient morbidity (Bordin et al., 2017; Reis et al., 2019; Tuzzolo Neto et al., 2020; Gutierres et al., 2023).

Well-founded studies in the literature emphasize the need to establish minimum distances for proper implant positioning. Thus, it is recommended that implants be placed 1.5 mm from the tooth or 3 mm between implants, in addition to a horizontal bone width of 6 mm considering conventional implants (diameter ≥ 3.75 mm) for less crestal bone loss and

better papilla formation (Tarnow, Cho, and Wallace, 2000; Gutierres et al., 2023). The upper lateral incisor and lower incisor regions rarely provide sufficient space for the placement of regular platform implants. In view of this, narrow (≥ 3 mm and < 3.75 mm) and extra-narrow (> 3 mm) implants have come onto the market to meet the rehabilitation needs of these extremely challenging scenarios, both in terms of function and aesthetics.

Extra-narrow implants are characterized by their reduced diameter, less than 3 mm, and are found in single or two-piece forms when the implant and prosthetic component are separate (Al-Johany et al., 2016; Bordin et al., 2017). They entered the dental market due to the growing need for implants that could replace teeth with reduced width, such as upper lateral incisors and lower central and lateral incisors. In order to maintain the principles of good positioning in regions where mesiodistal space is so limited, the solution adopted by companies was to invest in a significant reduction in the diameter of osseointegrated implants (Klein, Schiegnitz, and Al-Nawas, 2014).

Despite their recent arrival on the market, extra-narrow implants have shown high success rates in in vitro studies (Bordin et al., 2017; Tuzzolo Neto et al., 2020; Gutierres et al., 2023), as well as in clinical studies (Marcantonio Junior et al., 2022; Thomé et al., 2022; Ferreira et al., 2023), proving to be an effective alternative in the rehabilitation of reduced edentulous spaces. Bordin *et al.* (2017) observed that the survival rate of narrow (Ø 3.3 mm) and extra-narrow (Ø 2.9 mm) implants was above 97% for tests with forces of 50 and 100 N. Corroborating this, Gutierres *et al.* (2023) tested the survival and failure of narrow and extra-narrow implants with diameters of 3.3 and 2.9 mm, respectively, of double-piece and monoblock implants with diameters of 3.0 and 2.5 mm. In this study, they concluded that there were no significant differences in the probability of survival in all tested groups, demonstrating that the implants were able to withstand forces compatible with the physiological forces present in the incisor and premolar region and that the failure mode was also identical for all groups, being restricted to the prosthetic abutment or its corresponding portion in monoblock implants. In a comparison between extra-narrow, narrow, and conventional implants subjected to tensile strength and maximum bending moment tests, it

was demonstrated that the larger the implant diameter, the greater its resistance to fracture (Tuzzolo Neto et al., 2020), which emphasizes the need for clinicians to follow the recommendations for indication when selecting implants for different regions to be rehabilitated. Given the above, the objective of this study was to report a clinical case of a young patient with agenesis of the upper lateral incisors rehabilitated with extra-narrow osseointegrated implants.

METHODS

This work consists of a qualitative and descriptive clinical case report that presents relevant information from the literature on the clinical, radiographic, and tomographic characteristics of case about extra-narrow implants, contributing to its understanding and appropriate therapeutic treatment for cases of lateral incisor agenesis. Ethical and legal aspects were respected, and the patient signed the Free and Informed Consent Form (FICF) provided by the Society for the Social Promotion of Cleft Lip and Palate Patients (PROFIS) - Bauru, São Paulo, Brazil, authorizing the diagnosis, treatment, and use of images for scientific purposes and publication in specialized journals.

CASE REPORT

Patient, 18 years old, sought the specialization course in Implant Dentistry at the Dental Institute of Surgery and Prosthetics (IOCP) for oral rehabilitation with osseointegrated implants. During the anamnesis and clinical examination, the patient reported having agenesis of the upper lateral incisors, having undergone previous treatment with temporary implants in the region of elements 12 and 22. Imaging exams, panoramic radiography (Figure 1A), periapical radiography (Figure 1B and C), and total maxillary computed tomography (Figure 1D-F) showed the temporary implants in position, as well as satisfactory horizontal and vertical bone tissue, however, with mesiodistal limitation in the region.

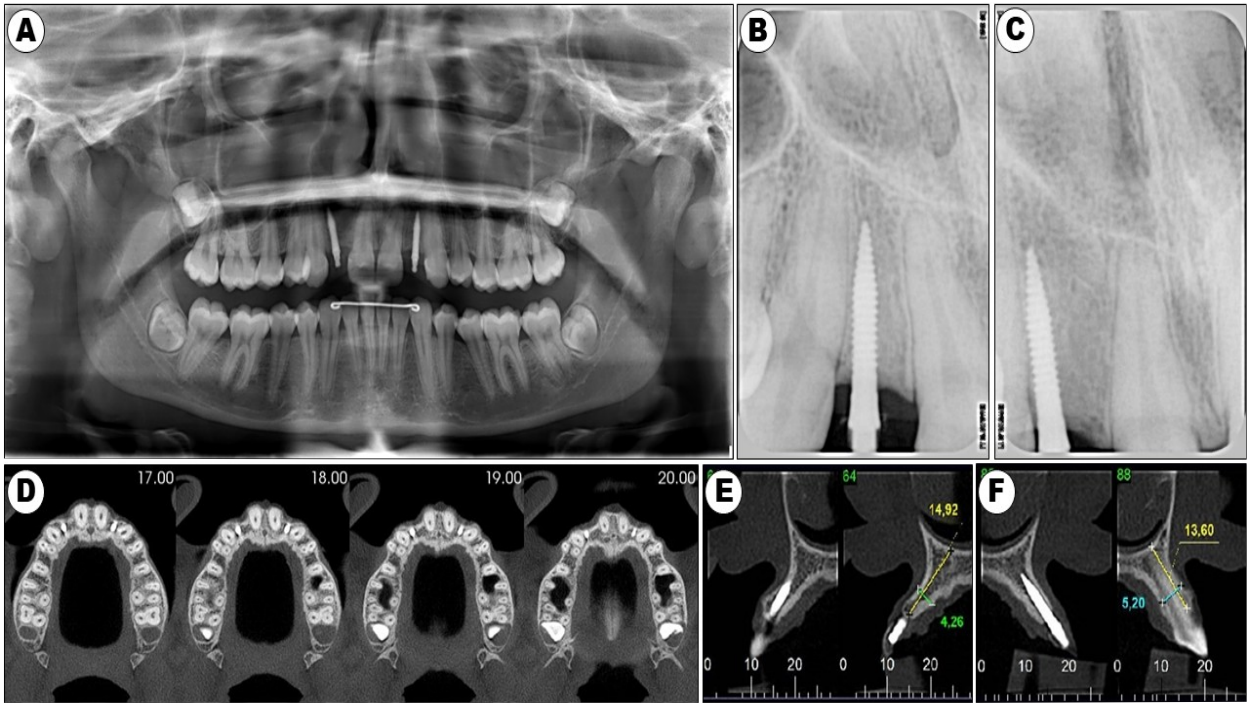

Figure 1 – A: Initial panoramic radiograph showing the presence of two temporary intraosseous implants in regions 12 and 22 **B:** Periapical radiographs of temporary implants region 12 **C:** Periapical radiographs of temporary implants region 22 **D:** Computed tomography - Axial tomographic sections show horizontal bone availability and the presence of temporary intraosseous implants **E:** Sagittal tomographic sections showing bone height of 14.92 mm and thickness of 4.26 mm in region 12 **F:** Sagittal tomographic sections showing bone height of 13.60 mm and thickness of 5.20 mm in region 22

Initial impressions of the upper and lower arches were taken for study purposes, followed by scanning of the upper arch (3Shape TRIOS 3 scanners) for planning and fabrication of the surgical guide using DICOM Viewer DentalCAD - EXOCAD® software (Align Technology, Inc, San José, California, USA) (Figures 2A and B).

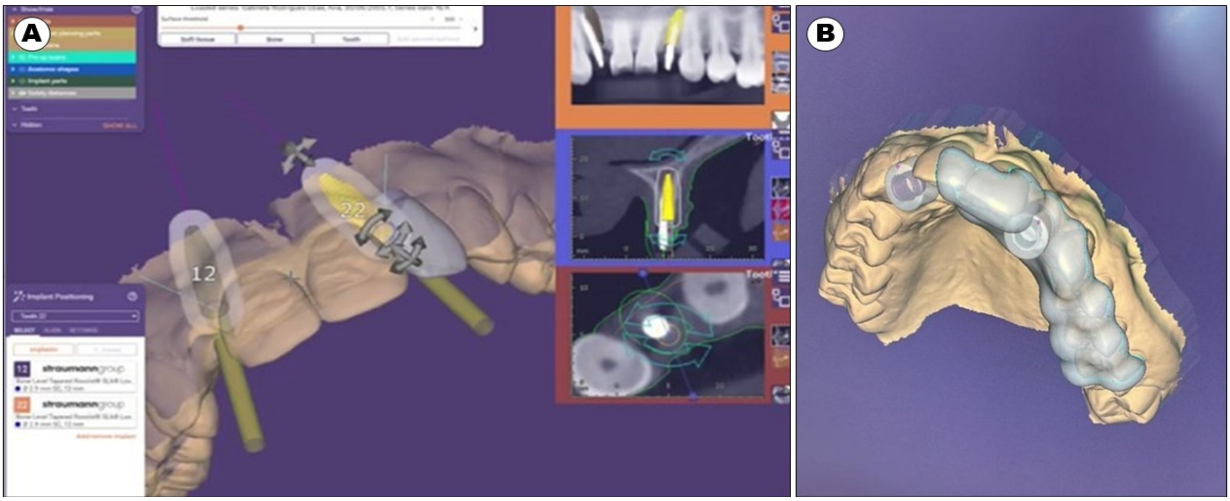

Figure 2 – A: Virtual planning of intraosseous implants 12 and 22 **B:** Surgical guide planning

After removing the dental crown and testing the surgical guide, the temporary implant in the region of element 12 was removed using an orthodontic mini-screw hexagonal wrench, and a BLT Ø 2.9x12mm SC SLActive®, Roxolid® implant (40 N.cm torque) was installed using the hybrid technique, with BioOss® biomaterial (0.25-1 mm granulation) applied in the vestibular region and a resin cylinder and crown installed, with each step being radiographed (Figures 3A and B).

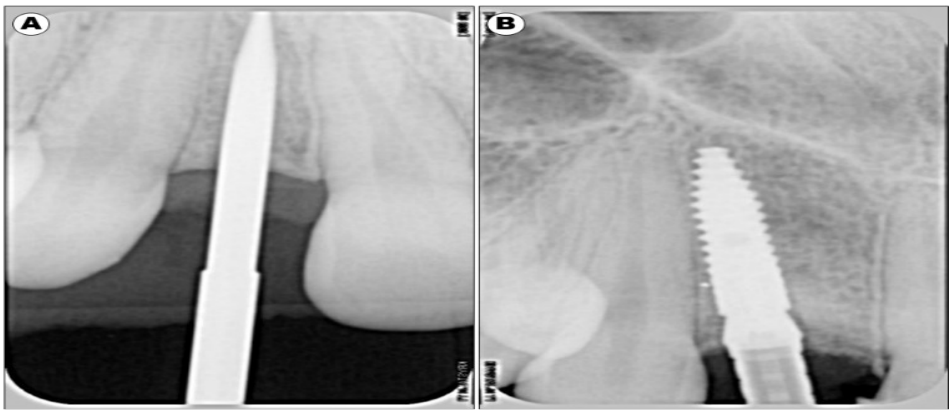

Figure 3 – Trans- and postoperative periapical radiographs of region 12 **A:** Parallelometer in position for drilling check **B:** Immediate postoperative period after implant placement with oval temporary abutment for crown

After 28 days, the same surgical steps were performed in the region of tooth 22 (Figure 4A-C), installing a BLT Ø 2.9x10mm SC, SLActive®, Roxolid® implant (40 N.cm torque) (Figure 4D, E, F and H). All trans- and post-operative stages were radiographed (Figure 4G and I).

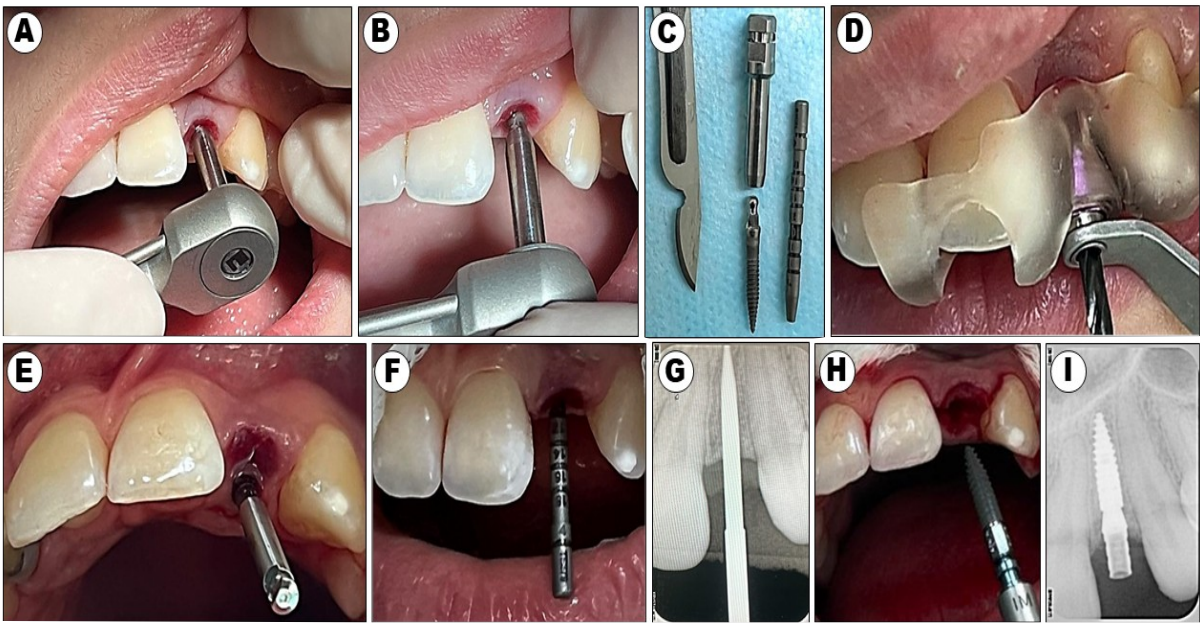

Figure 4 – A: Removal of the temporary implant in region 22 with the aid of an orthodontic mini-screw hexagonal wrench - Adaptation of the component on the head of the temporary implant **B:** Application of reverse torque on the ratchet to remove the temporary implant **C:** View of the temporary implant immediately after removal **D:** Surgical guide in position for drilling with a lance drill **E:** Milling with a 2.2 drill **F:** Evaluation of the drilling with the parallelometer **G:** Trans and post operative periapical radiographs of region 22 - Parallelometer in position to assess the positioning of the drilling **H:** Installation of the BLT Ø 2.9x10mm SC, SLActive®, Roxolid® implant using the hybrid technique **I:** Immediate postoperative period after implant placement - Oval temporary abutment for crown

Five months after implant placement, a scan body scan was performed to fabricate the zirconia crowns. Six months after implant placement, Variobase® prosthetic abutments were selected, the crowns were tried in and cemented onto the prosthetic components, periapical radiographs were taken, and occlusal adjustment was performed (Figures 5E and H).

The patient returned for a maintenance checkup 2 months after rehabilitation with zirconia crowns, with no complaints and no changes in either region (Figure 5A-D and F-G).

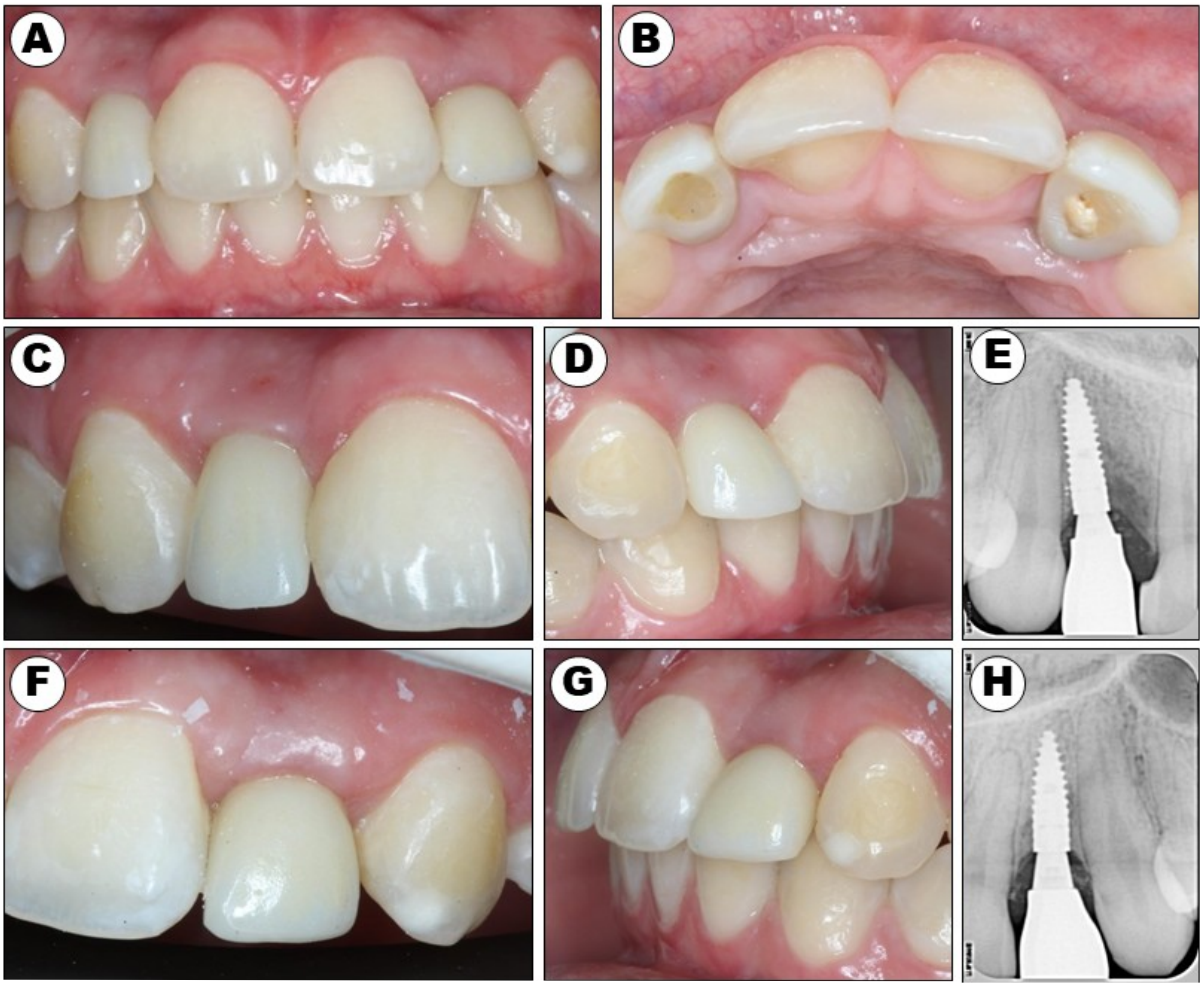

Figure 5 – A: Clinical appearance two months after zirconia crown placement - Front view **B:** Occlusal view **C:** Detailed front view of region 12 **D:** Lateral view of region 12 **E:** Periapical radiographs after installation of zirconia crowns on Variobase® of region 12 **F:** Detailed front view of region 22 **G:** Lateral view of region 22 **H:** Periapical radiographs after installation of zirconia crowns on Variobase® of region 22

At the last checkup, 19 months after implant placement, the patient was satisfied with the treatment and had no complaints. Clinically, healthy peri-implant gingival tissue with satisfactory volume and quality was noted, and panoramic and periapical radiographs showed normal appearance and good peri-implant bone maintenance (Figure 6A-C).

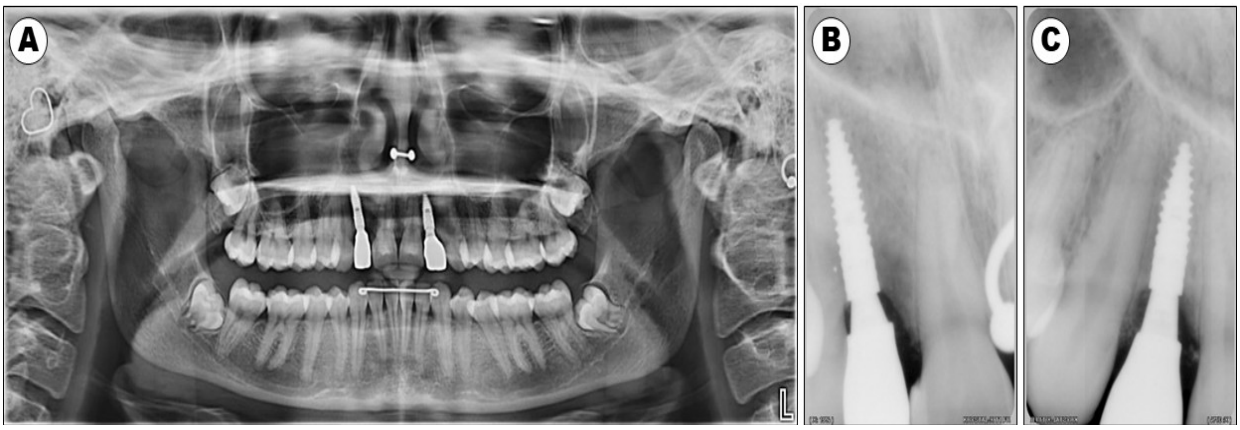

Figure 6 – A: Panoramic X-ray control 19 months after implant placement in regions 12 and 22 **B:** Periapical control radiographs 19 months after the installation of osseointegrated implants of region 12 **C:** Region 22

DISCUSSION

Hypodontia is the most common developmental dental anomaly. It occurs sporadically and familiarly and may be associated with syndromes or be isolated. Dental agenesis is transmitted through an autosomal dominant, recessive, or X-linked condition (Vastardis et al., 1996). Thus, the highest incidence occurs in women (Terheyden and Wüsthoff, 2015), affecting ethnic groups in different variations, 1.6 to 9.6%, with third molars being the most absent teeth in the population (20%), followed by lower second premolars and upper lateral incisors (Mostowska, Biedziak, and Jagodzinski., 2012).

Patients with dental agenesis can choose different forms of treatment, including orthodontic, prosthetic, restorative, or implant-supported (Krieger et al., 2009; De-Marchi, Pini, and Pascotto, 2012; Terheyden and Wüsthoff, 2015; Attia et al., 2019). Temporary implants have shown the most satisfactory results in the treatment of dental agenesis in adolescent patients (Cope and McFadden, 2014; Terheyden and Wüsthoff, 2015; Lambert et al., 2016; Casaña-Ruiz et al., 2023). These have a reduced diameter, 1.8 to 2.5 mm, and are generally single-piece. Their indication is more interesting from the age of 15, after the peak of facial skeletal growth, to reduce the risks of interference in the passive eruption of teeth

adjacent to the implanted region. Their monoblock structure is the main reason for their replacement by a more advanced implant that allows for more refined prosthetic solutions for aesthetic regions (Lambert et al., 2016; Chrcanovic, 2018). The patient should be advised to replace temporary implants and prosthetic crowns with osseointegrated implant systems that will effectively support occlusal loads in the anterior region and ensure better aesthetics and maintenance of peri-implant health.

Considering the reduced space in the upper lateral incisor and lower incisor areas, extra-narrow implants are more favorable when compared to narrow implants, since their reduced diameter provides the ideal distance between the implant and adjacent teeth, reducing crestal bone loss and allowing papilla formation (Tarnow, Cho, and Wallace, 2000; Thomé et al., 2022). It is known that a distance of less than 3 mm between adjacent teeth and implants, regardless of vertical distance, results in the non-formation of papillae (Gastaldo, Cury, and Sendyk, 2004), affecting the aesthetics, function, and biology of the protective and supporting periodontium, which in many cases makes the use of narrow implants in the region in question unfeasible.

The high survival rate of extra-narrow implants is a result of the evolution of their macrogeometry (Thomé et al., 2022), mainly due to the use of titanium alloys such as titanium-aluminum-vanadium (Ti-6Al-4V), which provides better mechanical properties when compared to commercially pure titanium (Gutierres et al., 2023). However, it is essential to consider the manufacturers' recommendations, as well as their restricted indication for regions of low masticatory stress (Marcantonio Junior et al., 2022). Extra-narrow implants are optimal for rehabilitating upper lateral incisors (Thomé et al., 2022) and lower incisors, on which the bite force does not exceed the range of 50 to 100 N. Failure to observe these requirements can lead to fractures and other treatment failures (Bordin et al., 2017; Reis et al., 2019).

CONCLUSION

It can be concluded that extra-narrow implants are a reliable and effective solution for the rehabilitation of regions with low masticatory stress, providing aesthetics, function, and high satisfaction rates in patients.

REFERENCES

AL-JOHANY, S. S.; AL AMRI, M. D.; ALSAEED, S.; ALALOLA, B. Dental implant length and diameter: a proposed classification scheme. *Journal of Prosthodontics*, v. 26, n. 3, p. 252-260, 2016. DOI: 10.1111/jopr.12517.

ATTIA, S.; SCHAAF, H.; EL KHASSAWNA, T. et al. Oral rehabilitation of hypodontia patients using an endosseous dental implant: functional and aesthetic results. *Journal of Clinical Medicine*, v. 8, n. 10, p. 1687, 2019. DOI: 10.3390/jcm8101687.

BORDIN, D.; BERGAMO, E. T. P.; FARDIN, V. P.; COELHO, P. G.; BONFANTE, E. A. Fracture strength and probability of survival of narrow and extra-narrow dental implants after fatigue testing: in vitro and in silico analysis. *Journal of the Mechanical Behavior of Biomedical Materials*, v. 71, p. 244-249, 2017. DOI: 10.1016/j.jmbbm.2017.03.022.

CASAÑA-RUIZ, M. D.; CATALÀ-PIZARRO, M.; BORRÁS-AVIÑÓ, C. et al. Implants as a treatment alternative in children with multiple agenesis: systematic review and meta-analysis. *Journal of Clinical and Experimental Dentistry*, v. 15, n. 4, p. e324-e337, 2023. DOI: 10.4317/jced.60168.

CHEN, P.; NIKOYAN, L. Guided implant surgery: a technique whose time has come. *Dental Clinics of North America*, v. 65, n. 1, p. 67-80, 2021. DOI: 10.1016/j.cden.2020.09.005.

CHRCANOVIC, B. R. Dental implants in patients with ectodermal dysplasia: a systematic review. *Journal of Cranio-Maxillofacial Surgery*, v. 46, n. 8, p. 1211-1217, 2018. DOI: 10.1016/j.jcms.2018.05.038.

COPE, J. B.; MCFADDEN, D. Temporary replacement of missing maxillary lateral incisors with orthodontic miniscrew implants in growing patients: rationale, clinical technique, and long-term results. *Journal of Orthodontics*, v. 41, supl. 1, p. S62-S74, 2014. DOI: 10.1179/1465313314Y.0000000112.

DE-MARCHI, L. M.; PINI, N. I.; PASCOTTO, R. C. The relationship between smile attractiveness and esthetic parameters of patients with lateral agenesis treated with tooth recontouring or implants. *Clinical, Cosmetic and Investigational Dentistry*, v. 4, p. 43-49, 2012. DOI: 10.2147/CCIDEN.S37668.

ESQUIVEL, J.; MEDA, R. G.; BLATZ, M. B. The impact of 3D implant position on emergence profile design. *The International Journal of Periodontics & Restorative Dentistry*, v. 41, n. 1, p. 79-86, 2021. DOI: 10.11607/prd.5126.

FERREIRA, F. N. H.; MOREIRA NETO, J. J. S.; DE NEGREIROS, W. A.; KURITA, L. M.; SILVA, P. G. B. Evaluation of extra-narrow diameter implants in the oral rehabilitation of young patients after oral trauma: a prospective study. *Dental Traumatology*, v. 39, n. 3, p. 248-256, 2023. DOI: 10.1111/edt.12822.

GANZ, S. D. Three-dimensional imaging and guided surgery for dental implants. *Dental Clinics of North America*, v. 59, n. 2, p. 265-290, 2015. DOI: 10.1016/j.cden.2014.11.001.

GASTALDO, J. F.; CURY, P. R.; SENDYK, W. R. Effect of the vertical and horizontal distances between adjacent implants and between a tooth and an implant on the incidence of interproximal papilla. *Journal of Periodontology*, v. 75, n. 9, p. 1242-1246, 2004. DOI: 10.1902/jop.2004.75.9.1242.

GOYAL, S.; MASOOD, M.; LE, C. et al. Comparative bone graft evaluation for dental implant success: an evidence-based review. *Journal of Long-Term Effects of Medical Implants*, v. 31, n. 3, p. 33-44, 2021. DOI: 10.1615/JlongTermEffMedImplants.2021038292.

GUPTA, S.; MORTELLARO, C.; PANDA, S. et al. Dental implant survival rate in irradiated and non-radiated patients: a systematic review and meta-analysis. *Journal of Biological Regulators and Homeostatic Agents*, v. 35, n. 2, supl. 1, p. 53-65, 2021. DOI: 10.23812/21-2supp1-5.

GUTIERRES, E.; BERGAMO, E. T. P.; CARVALHO, L. F. et al. Single geometry abutment for narrow and extra-narrow implant systems: survival and failure modes. *Journal of the Mechanical Behavior of Biomedical Materials*, v. 143, p. 105872, 2023. DOI: 10.1016/j.jmbbm.2023.105872.

HEIMES, D.; BECKER, P.; PABST, A. et al. How does dental implant macrogeometry affect primary implant stability? A narrative review. *International Journal of Implant Dentistry*, v. 9, n. 1, p. 20, 2023. DOI: 10.1186/s40729-023-00485-z.

JACOBS, R.; SALMON, B.; CODARI, M.; HASSAN, B.; BORNSTEIN, M. M. Cone beam computed tomography in implant dentistry: recommendations for clinical use. *BMC Oral Health*, v. 18, n. 1, p. 88, 2018. DOI: 10.1186/s12903-018-0523-5.

KLEIN, M. O.; SCHIEGNITZ, E.; AL-NAWAS, B. Systematic review on success of narrow-diameter dental implants. *International Journal of Oral & Maxillofacial Implants*, v. 29, supl., p. 43-54, 2014. DOI: 10.11607/jomi.2014suppl.g1.3.

KRIEGER, O.; MATULIENE, G.; HÜSLER, J. et al. Failures and complications in patients with birth defects restored with fixed dental prostheses and single crowns on teeth and/or implants. *Clinical Oral Implants Research*, v. 20, n. 8, p. 809-816, 2009. DOI: 10.1111/j.1600-0501.2009.01720.x.

LAMBERT, F.; BOTILDE, G.; LECLOUX, G.; ROMPEN, E. Effectiveness of temporary implants in teenage patients: a prospective clinical trial. *Clinical Oral Implants Research*, v. 28, n. 9, p. 1152-1157, 2017. DOI: 10.1111/clr.12931.

MARCANTONIO, E. JÚNIOR et al. Influence of risk factors on the long-term survival of oral rehabilitation with extra-narrow implants: a retrospective study. *Journal of Applied Oral Science*, v. 30, e20220089, 2022. DOI: 10.1590/1678-77572022-0089.

MOSTOWSKA, A.; BIEDZIAK, B.; JAGODZINSKI, P. P. Novel MSX1 mutation in a family with autosomal-dominant hypodontia of second premolars and third molars. *Archives of Oral Biology*, v. 57, n. 6, p. 790-795, 2012. DOI: 10.1016/j.archoralbio.2012.01.003.

REIS, T. A. D.; ZANCOPÉ, K.; KARAM, F. K.; NEVES, F. D. D. Biomechanical behavior of extra-narrow implants after fatigue and pull-out tests. *Journal of Prosthetic Dentistry*, v. 122, n. 1, p. 54.e1-54.e6, 2019. DOI: 10.1016/j.prosdent.2019.04.005.

SMITH NOBREGA, A. et al. Irradiated patients and survival rate of dental implants: a systematic review and meta-analysis. *Journal of Prosthetic Dentistry*, v. 116, n. 6, p. 858-866, 2016. DOI: 10.1016/j.prosdent.2016.04.025.

SMITKARN, P.; SUBBALEKHA, K.; MATTHEOS, N.; PIMKHAOKHAM, A. The accuracy of single-tooth implants placed using fully digital-guided surgery and freehand implant surgery. *Journal of Clinical Periodontology*, v. 46, n. 9, p. 949-957, 2019. DOI: 10.1111/jcpe.13160.

TARNOW, D. P.; CHO, S. C.; WALLACE, S. S. The effect of inter-implant distance on the height of interimplant bone crest. *Journal of Periodontology*, v. 71, n. 4, p. 546-549, 2000. DOI: 10.1902/jop.2000.71.4.546.

TERHEYDEN, H.; WÜSTHOFF, F. Occlusal rehabilitation in patients with congenitally missing teeth: dental implants, conventional prosthetics, tooth autotransplants, and preservation of deciduous teeth—a systematic review. *International Journal of Implant Dentistry*, v. 1, n. 1, p. 30, 2015. DOI: 10.1186/s40729-015-0025-z.

THOMÉ, G.; VIANNA, C. P.; CALDAS, W. et al. Clinical and radiographic outcomes of maxillary lateral incisors rehabilitation using Morse taper connection extra-narrow implants at 12-month follow-up: a case report. *Clinical Case Reports*, v. 10, n. 8, e6248, 2022. DOI: 10.1002/ccr3.6248.

TUZZOLO NETO, H. et al. A comparative analysis of implants presenting different diameters: extra-narrow, narrow, and conventional. *Materials*, v. 13, n. 8, p. 1888, 2020. DOI: 10.3390/ma13081888.

VASTARDIS, H. et al. A human MSX1 homeodomain missense mutation causes selective tooth agenesis. *Nature Genetics*, v. 13, n. 4, p. 417-421, 1996. DOI: 10.1038/ng0896-417.

WIN, K. Z.; PIMKHAOKHAM, A.; KABOOSAYA, B. Comparing bone graft success, implant survival rate, and marginal bone loss: a retrospective study on materials and

influential factors. *Journal of Oral Implantology*, v. 50, n. 4, p. 300-307, 2024. DOI: 10.1563/aaid-joi-D-23-00165.

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