Alveolar Ridge Reconstruction Using Autologous Tooth Graft: Insights from a Malaysian Case of Anterior Maxillary Trauma

Zulkefli Mohd Idros
Medini Dental Clinic Taman Daya

Mohamad Ikhwan Jamaludin
Department of Biomedical Engineering and Health Sciences, Faculty of Electrical Engineering, Universiti Teknologi Malaysia

Mohamad Ikhwan Kori
Department of Biomedical Engineering and Health Sciences, Faculty of Electrical Engineering, Universiti Teknologi Malaysia

Muhammad Faiz Md Shakhih
Department of Biomedical Engineering and Health Sciences, Faculty of Electrical Engineering, Universiti Teknologi Malaysia

他

https://doi.org/10.5109/7395743

出版情報：Proceedings of International Exchange and Innovation Conference on Engineering & Sciences (IEICES). 11, pp.1763-1769, 2025-10-30. International Exchange and Innovation Conference on Engineering & Sciences
バージョン：

Alveolar Ridge Reconstruction Using Autologous Tooth Graft: Insights from a Malaysian Case of Anterior Maxillary Trauma

Zulkefli Mohd Idros[1*], Mohamad Ikhwan Jamaludin[2,3*], Mohamad Ikhwan Kori[2], Muhammad Faiz Md Shakhih[2], Muhammad Izzuddin Abd Samad[2], Muhammad Hanif Ramlee[2,4]
[1]Medini Dental Clinic Taman Daya, No 01, 50, Jln Pinang 52, Taman Daya, 81100 Johor Bahru, Johor Darul Ta'zim
[2]Department of Biomedical Engineering and Health Sciences, Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia.
[3]Bioinspired Device and Tissue Engineering (BIOINSPIRA) Research Group, Department of Biomedical Engineering and Health Sciences, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia.
[4]Rehabilitation Nexus (RehabNex) Research Group, Department of Biomedical Engineering and Health Sciences, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
*medinizul@gmail.com, *mohamad.ikhwan@utm.my

Abstract: *Autogenous dentin grafts (AutoBT) utilize extracted teeth to create a biocompatible scaffold, offering a donor-site-free alternative to conventional bone substitutes. This case report outlines the rehabilitation of a traumatically damaged anterior maxilla in a 34-year-old male using chairside-processed dentin granules produced with the BonMaker M-2 Cube. Serial Cone-beam computed tomography (CBCT) imaging at two weeks, three, eight, and twelve months confirmed ridge preservation and progressive lamellar bone formation around the remaining graft particles. All three implants placed demonstrated strong primary stability and remained well-integrated at one year, with marginal bone resorption below one millimeter. This case represents one of the first published Malaysian experiences utilizing AutoBT for alveolar ridge reconstruction. The clinical outcomes observed herein support its function as a biologically active grafting material with both osteoconductive and putative osteoinductive properties. Continued investigation is necessary to substantiate its long-term effectiveness.*

Keywords: Autologous Dentin Graft, Demineralized Dentin Matrix, Guided Bone Regeneration, Bone Grafting Technology, BonMaker M-2 Cube

1. INTRODUCTION

Traumatic avulsion and root fracture injuries frequently result in the rapid and localized resorption of the adjacent alveolar bone plate [1]. This progressive bone loss can diminish the ridge width by as much as 50 percent within a twelve-week period, thereby compromising accurate implant placement in the aesthetically critical region of the anterior maxilla [2]. When such trauma involves segmental fractures or fragmentation of the buccal plate, the resulting loss of labial support further affects phonetic function and soft tissue appearance. In these cases, reconstruction of the hard tissue becomes essential.
The use of autogenous bone grafts, either in block or particulate form, sourced from intraoral regions such as the mandibular symphysis or ramus, or from extraoral locations including the iliac crest, has traditionally represented the gold standard. These grafts provide viable osteogenic cells along with a biologically active matrix that supports both osteoconduction and osteoinduction [3]. However, the harvesting process is associated with several limitations, including restricted graft volume, extended surgical time, and a complication rate ranging between 8 percent and 20 percent. These complications may include infection, hematoma, prolonged postoperative pain, and sensory disturbances. As a result, there has been increasing interest in alternative grafting materials that avoid secondary surgical sites while maintaining equivalent biological performance [4].
The autogenous dentin graft (AutoBT) has emerged as a resource-efficient alternative that repurposes a patient's extracted tooth into a demineralized dentin matrix scaffold. The composition of dentin, which is approximately 70 percent hydroxyapatite, 20 percent type I collagen, and 10 percent water, closely resembles that of cortical bone [5]. The organic portion of dentin contains non-collagenous proteins such as bone morphogenetic proteins 2 and 7, transforming growth factor beta 1, vascular endothelial growth factor, and insulin-like growth factors. The process of partial demineralization allows these proteins to become bioavailable, thereby providing the scaffold with confirmed osteoconductive properties and potential osteoinductive activity [6]. Since the material originates from the patient's own tissue, there is no risk of immunologic rejection or cross-species disease transmission.
The clinical use of AutoBT at the point of care has been facilitated by the development of compact processing systems such as the Smart Dentin Grinder, Tooth Transformer, and BonMaker M-2 Cube. These devices are capable of grinding, sterilizing, and partially demineralizing extracted teeth into granules measuring between 300 and 1,000 micrometers within a time frame of less than twenty minutes [7]. Recent systematic reviews and meta-analyses indicate that AutoBT yields outcomes in ridge preservation and peri-implant bone maintenance that are statistically comparable to those achieved with deproteinized bovine bone mineral and particulate autografts. Importantly, it does so without introducing the morbidity associated with donor site harvesting [8, 9, 10].

In this clinical context, we present the treatment of a 34 year old male patient who sustained a traumatic fracture in the anterior maxilla. The defect was reconstructed in a single surgical session using AutoBT prepared chair-side with the BonMaker system. Following tooth extraction, immediate implant placement was carried out, accompanied by the insertion of autogenous tooth-derived bone graft (autoBT) within the extraction socket during the same clinical visit. This case report outlines the procedural protocol, highlights relevant cone beam computed tomography findings. The goal is to provide guidance on the effective use of dentin-derived grafts as a biologically active and harvest-free alternative for complex implant site reconstruction following trauma.

2. CASE REPORT

Twenty-four hours following a motorcycle accident, a 34-year-old male with no systemic health issues and a non-smoking history presented to our clinic exhibiting symptoms of anterior maxillary discomfort, compromised masticatory function, and lacerations of the upper lip. Clinical extraoral evaluation revealed: (i) a 10 mm full-thickness laceration traversing the vermilion border of the left upper lip, (ii) a minor 1 mm linear tear at the left oral commissure, (iii) superficial abrasions scattered across the chin, and (iv) notable edema of the lower lip. An ulcerative lesion measuring approximately 10 × 15 mm was identified on the inner surface of the lower left lip, extending into the labial sulcus adjacent to tooth 33. Intraoral inspection found tooth 21 exhibiting Miller Grade III mobility alongside a mesio-incisal oblique crown fracture, while tooth 11 had sustained a horizontal crown fracture. Both teeth were significantly sensitive to percussion and palpation, with pronounced swelling in the surrounding labial sulcus.

Cone-beam computed tomography (CBCT) imaging (voxel resolution: 0.076 mm) indicated a comminuted defect in the labial cortical bone surrounding tooth 21, widened periodontal ligament spaces at the apices of teeth 11 and 21, and a distinct apical-third fracture of tooth 11 (see Fig. 2a–d). Tooth 22 presented with considerable mobility and an associated periapical radiolucency, rendering it non-viable for restorative procedures. Upon obtaining informed consent, emergency intervention included meticulous decontamination and hemostasis of all soft-tissue injuries. The lip laceration was approximated using six interrupted 4-0 black silk sutures, and the commissural tear was closed with a single suture of the same material. The patient was prescribed prophylactic antibiotics (amoxicillin 500 mg orally every 8 hours for five days) and analgesics (mefenamic acid 250 mg orally every 8 hours for five days), along with standard postoperative instructions.

With informed written consent, teeth 11, 21, and 22 were atraumatically extracted under local anesthesia (2% lidocaine with 1:100,000 epinephrine) to mitigate alveolar ridge deterioration and facilitate implant placement. The extracted teeth were processed chairside into autogenous dentin graft (AutoBT) material using the BonMaker M-2 Cube (Korea Dental Solution). Gross debris, calculus, and soft tissues were removed; enamel crowns and restorative components were separated, and the pulp was extirpated. Root dentin was superficially curetted to enhance surface roughness, rinsed with sterile saline, and transferred to the sealed chamber of the device for a 10-second grinding and 5-minute partial demineralisation, yielding granules sized 300–1000 µm [11]. Particles under 300 µm were excluded via a triple-sieve system (see Fig. 1a–c). A total of 1.8 cc of autogenous tooth-derived bone graft (autoBT), prepared from the extracted teeth 11, 21, and 22.

A full-thickness mucoperiosteal flap was elevated, granulation tissue was excised, and bony defect margins were perforated using a round carbide bur. Subsequently, the implant cavities were prepared, and three implants were placed: two Dentium SuperLine II implants (4 × 8 mm for tooth 11 and 4 × 10 mm for tooth 21) and one Dentium NR Line implant (3 × 10 mm for tooth 22). All implants were positioned more palatally and approximately 3 mm subcrestally to optimise primary stability and prosthetic alignment. Each implant was inserted and torqued to a value exceeding 35 Ncm, and an implant stability quotient (ISQ) averaging 78 ± 2 was recorded, indicating adequate primary stability for successful osseointegration. The implants were subsequently covered with healing abutments to facilitate soft tissue healing and maintain access for future prosthetic procedures.

The hydrated AutoBT granules were compactly placed into the extraction sockets and labial defect (see Fig. 1d), then lightly condensed with a plugger to optimize contact with the host bone and the implant. Healing abutments were placed on the implants to maintain transmucosal access. Wound closure was achieved with interrupted 4-0 polyglactin-910 sutures under tension-free conditions when combined with the application of a resorbable collagen membrane. Postoperative care involved twice-daily rinsing with 0.12% chlorhexidine gluconate for two weeks, a three-day course of mefenamic acid (250 mg orally every 8 hours), and written oral hygiene guidance [12].

A follow-up CBCT scan conducted two weeks post-grafting (see Fig. 3) demonstrated stable particulate graft architecture, with a bucco-palatal ridge width measuring 4.1 mm coronally and 3.9 mm apically. No signs of particle migration or membrane displacement were observed. At the three-month mark (see Fig. 4), ridge dimensions were preserved (4.1 mm coronal, 3.9 mm apical), and a continuous cortical outline with early trabecular graft integration was evident, indicating successful preliminary mineralization of the autogenous dentin matrix.

At the six-month follow-up examination, the augmented ridge appeared structurally robust and well-perfused, with no visible demarcation between the grafted and native osseous tissues. A CBCT scan conducted eight months post-placement and following grafting (see Fig. 5) confirmed preservation of a 3.9 mm ridge width at the level of the implant collars, with the labial bone contour remaining intact [13].

After approximately four months of transmucosal healing, the prosthetic phase was initiated, and the final restorations were delivered, marking the beginning of functional loading. At the 12-month follow-up, which marked one year after grafting and the immediate implant placement, clinical and radiographic assessments indicated peri-implant marginal bone loss of less than 1 mm. The surrounding keratinized mucosa remained healthy and stable. CBCT confirmed that the ridge width had been preserved at 3.6 mm, as shown in Fig. 6. The patient reported complete resolution of all preoperative symptoms and expressed a high degree of satisfaction with both the functional performance and esthetic appearance of the final prosthetic outcome.

Fig. 1. Chairside preparation and application of autogenous tooth graft (AutoBT). a) Extracted incisors placed in the stainless-steel grinding chamber. (b) Dentin granules obtained after mechanical milling. (c) Sequential sieving yields 300–1000 µm particles ideal for grafting. (d) Hydrated AutoBT being packed into the anterior maxillary defect.

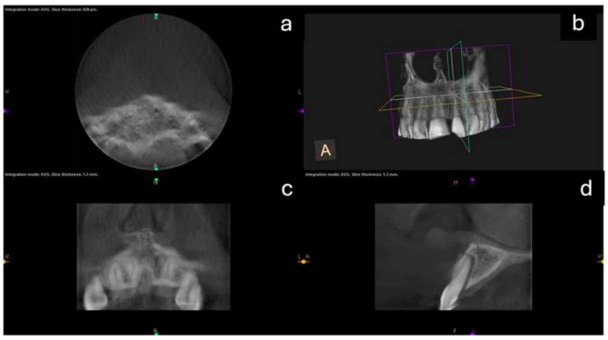

Fig. 2. Pre-operative CBCT demonstrating the traumatic defect in the anterior maxilla. (a) Axial slice reveals complete loss of the labial cortical plate and a bucco-palatal ridge width < 1 mm. (b) Volume-rendered view with the re-oriented slicing plane delineates the comminuted labial-plate fracture and buccal displacement of tooth 21. (c) Coronal slice shows vertical loss of the labial plate and over-riding fracture fragments. (d) Sagittal slice through tooth 21 depicts an apical third fracture line and loss of buccal cortical continuity.

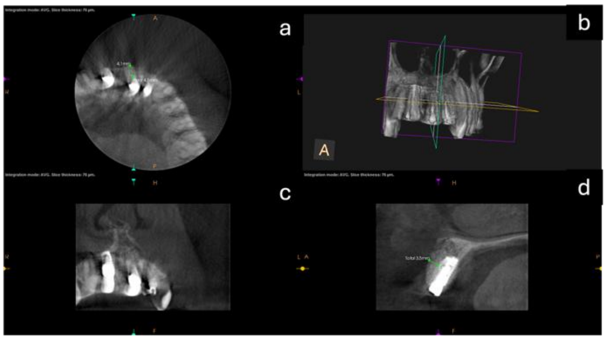

Fig. 3. Two-week postoperative CBCT assessment of the AutoBT-grafted anterior maxilla. (a) Axial slice showing a 4.1 mm bucco-palatal ridge width (green calibre). (b) 3-D volume-rendering with re-oriented slicing plane. (c) Sagittal slice confirming preservation of the labial plate. (d) Coronal view at the former tooth-21 sockets demonstrating graft fill and a 3.6 mm ridge width.

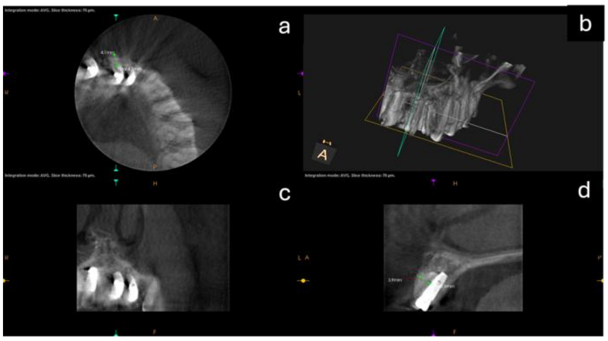

Fig. 4. Three-month postoperative CBCT of the AutoBT-augmented ridge. (a) Axial slice demonstrating preservation of the bucco-palatal ridge width (green calibre). (b) 3-D volume-rendered model with the re-oriented slicing plane super-imposed. (c) Sagittal slice showing a continuous labial cortical outline and early trabecular infill within the grafted socket. (d) Coronal slice centred on the former tooth-21 site, showing good ridge width and homogeneous radiopacity indistinguishable from adjacent native bone.

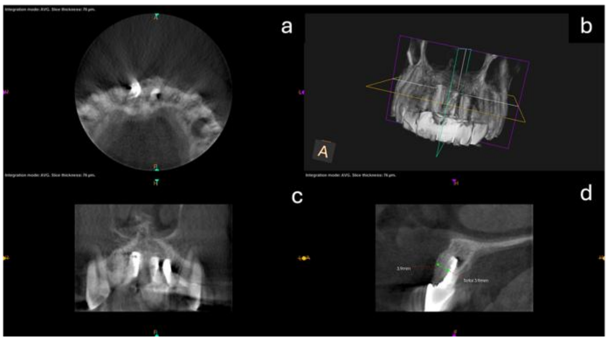

Fig. 5. Eight-month postoperative CBCT. (a) Axial slice confirming a stable ridge width around the coronal aspect of the implant. (b) 3-D reconstruction illustrating correct prosthetic emergence and an intact labial plate. (c) Sagittal slice revealing mature trabecular architecture contiguous with the implant threads. (d) Coronal slice through implant (21) showing dense peri-implant bone with no radiolucent halos.

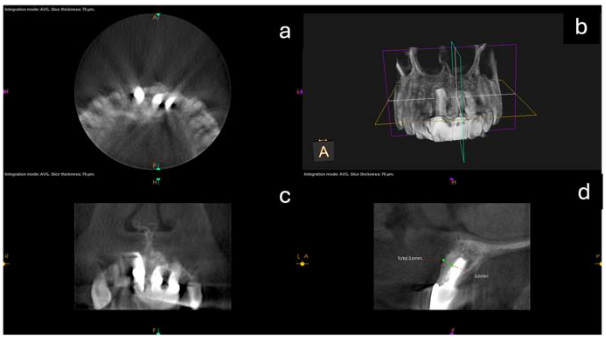

Fig. 6. Twelve-month CBCT (eight-months functional loading) confirming long-term ridge preservation. (a) Axial slice documenting a 3.6 mm bucco-palatal ridge width (green calibre). (b) Volume-rendered view

displaying an intact cortical envelope and harmonious gingival contour. (c) Sagittal slice showing corticalisation of the crestal bone and absence of late resorption. (d) Coronal slice depicting uniform lamellar bone density completely encasing the implant; no residual graft material or peri-implant radiolucency is present.

3. DISCUSSION

This case highlights the clinical application of chairside-prepared autogenous dentin grafting (AutoBT) as a reliable method for alveolar ridge augmentation in immediate implant placement. While AutoBT has likely been employed in Malaysian practice, this report represents one of the earliest formal documentations of its use, with both clinical and radiographic follow-up supporting its effectiveness. Clinical follow-up and sequential radiographic assessments over a twelve-month period consistently demonstrated favorable graft behavior. The initial ridge dimensions following grafting, measured at 4.1 mm at the coronal level and 3.5 mm at the apical level (see Fig. 3), showed minimal variation throughout the year. Later assessments, including those illustrated in Fig. 4, Fig. 5, and Fig. 6, confirmed that changes in bucco-palatal width remained within approximately ± 0.4 mm. These findings support the interpretation of long-term volumetric stability and successful integration of the graft material, further evidenced by the preservation of cortical and trabecular bone continuity.

The positive regenerative outcome may be attributed to the biological resemblance between dentin and alveolar bone. Both tissues originate from neural crest cells and share a composition of approximately 70% hydroxyapatite and 20% type I collagen, along with a diverse array of non-collagenous proteins [5]. The partial demineralisation process maintains the dentin matrix as a scaffold while unmasking osteoinductive agents such as BMP-2, BMP-7, and TGF-β1. These factors are gradually released during particle remodeling and contribute to osteoblast recruitment and subsequent bone regeneration [14]. This supports the interpretation of the AutoBT as both an osteoconductive framework and a potentially osteoinductive material.

Key protocol adaptations contributed to the favorable clinical results. Root dentin was milled into particles ranging from 300 to 1000 µm, a size range reported to optimize scaffold durability and resorption dynamics [9]. A mildly acidic five-minute demineralisation protocol was applied to retain bioactive molecules while preserving particle strength. Sterility was maintained throughout the process using the sealed-cartridge BonMaker M-2 Cube system. These optimized parameters, when combined with the application of a resorbable collagen membrane and a tension-free primary closure technique, yielded a regenerated ridge suitable for implant support without the need for autogenous donor tissue. To further establish the clinical efficacy of chairside AutoBT in managing alveolar defects due to trauma, future research should focus on controlled trials assessing histomorphometric parameters and long-term implant performance.

Partial demineralisation was chosen over the use of either fully mineralised or entirely decalcified dentin. Immersing dentin in a 0.6 N hydrochloric acid solution for five minutes removed sufficient mineral content to expose embedded growth factors and enhance surface porosity. At the same time, the integrity of the collagen matrix was maintained, preserving structural rigidity and allowing for a gradual remodeling process [15]. Employing non-demineralised dentin could slow integration, while using completely demineralised material may lead to rapid resorption and inadequate maintenance of graft volume [16]. Alternative chairside systems have yielded comparable outcomes using 2% nitric acid or 17% ethylenediaminetetraacetic acid (EDTA) for 10 to 15 minutes. Despite differing protocols, the shared goal remains the creation of a partially demineralised, collagen-rich scaffold that balances mechanical resilience with biological efficacy [15].

Sterilisation of the dentin graft was achieved through a multi-step process involving sequential immersion in 70% ethanol, acid etching, and ultraviolet light exposure within a sealed chamber [17]. This protocol results in a sterility assurance level equal to or below 10^{-6}, and grafts processed in this manner consistently test negative for microbial contamination. Previous microbiological investigations affirm the safety of such grafts, even when applied to extraction sockets that communicate directly with the oral environment [18]. The absence of postoperative infection or foreign-body response in this case supports those findings. Although the final graft is devoid of viable cells and resembles a low-antigen xenograft, the use of autologous tissue eliminates the risk of immunologic rejection.

The clinical results in this case further strengthen the evidence supporting the effectiveness of chairside AutoBT. The regenerated ridge supported the placement of three implants, each achieving an insertion torque exceeding 35 N·cm and an implant stability quotient averaging 78 ± 2 was achieved. These values are widely accepted as predictive indicators for long-term implant success [14]. Kim et al. (2015) documented a one-year implant survival rate of 100% in 38 patients who received grafts made from autogenous demineralised dentin [19]. Similarly, a 2024 systematic review conducted by Picone et al. evaluated over 500 implants and reported a survival rate of at least 97%, marginal bone loss averaging ≤ 0.9 mm, and a complication incidence of less than 3%. These outcomes are comparable to those observed with autogenous bone blocks and bovine-derived xenografts [20]. Collectively, these data position chairside-processed dentin as a viable, biologically active alternative for alveolar bone regeneration without the need for a secondary donor site. Additional clinical studies provide strong support for the present findings. A randomized parallel-arm study involving 60 participants conducted by Del Canto-Díaz et al. (2019) demonstrated that socket preservation using demineralised autogenous dentin resulted in an average bone density of approximately 923 Hounsfield units (HU) ± 115 and vertical ridge resorption of only 0.3 ± 0.2 mm at the four-month mark. In contrast, sites that received no grafting intervention showed a lower mean density of around 564 HU ± 130 and greater vertical reduction of 1.2 ± 0.4 mm [21]. In a parallel investigation, a split-mouth trial compared particulate dentin with bovine-derived xenograft (Bio-Oss®), observing statistically equivalent horizontal ridge widths (difference less than 0.2 mm; $p > 0.05$) and similar bone density after six months. Implant placement proceeded uneventfully in both groups [22]. Taken together, these data suggest that chairside-processed autologous dentin provides comparable volumetric and radiographic outcomes to traditional xenografts, while maintaining the biologic compatibility and ethical benefits associated with using the patient's own tissue.

Outcomes relevant to patient experience are equally promising. Avoiding a second surgical site for bone harvesting significantly reduces discomfort, risk of nerve disturbance, and visible scarring—factors which frequently lead to better patient-reported results on standardised tools such as the visual analogue scale (VAS) and the Oral Health Impact Profile-14 (OHIP-14) [23]. In our case, the patient recorded a pain score no higher than 2 out of 10 by postoperative day three, reported no difficulty in performing daily functions, and expressed a strong preference for reusing their own extracted teeth rather than receiving grafts derived from bovine or synthetic sources. However, it is important to note that AutoBT is optimally indicated for confined alveolar sockets or moderate defects that can be contained and stabilized with a membrane. In situations involving larger segmental voids, the volume of available dentin may be insufficient, and the particulate graft lacks the rigidity offered by autogenous cortical blocks. In such cases, alternative strategies such as staged augmentation or mechanical support using titanium mesh may be necessary [24].

Processing time represents an important practical consideration. At our clinic, the full BonMaker M-2 Cube procedure, which involves mechanical milling, a five-minute immersion in 0.6 N hydrochloric acid, particle separation using triple sieving, and a final rinse with saline, required a total of 30 minutes to complete. Although this duration is slightly longer than that needed for harvesting traditional biologic grafts, it offers the significant advantage of avoiding donor-site trauma and the subsequent recovery period. When this modest increase in chair time is considered alongside the elimination of additional surgical morbidity, faster postoperative healing, and consistently high implant survival rates of 97% or greater at 12 months or beyond, chairside AutoBT stands out as both a clinically effective and economically sound approach for standard socket preservation and moderate ridge augmentation treatments.

Although long-term clinical data extending beyond five years for autogenous dentin grafts remain scarce, multiple studies have reported encouraging outcomes within follow-up periods ranging from 12 to 60 months [18]. Preclinical investigations suggest that partially demineralised dentin undergoes gradual resorption and replacement by host bone over an estimated duration of 6 to 36 months [25]. This aligns with the findings in the current case, where both ridge dimensions and peri-implant bone levels were maintained at the one-year evaluation. However, the clinical application of AutoBT in Southeast Asia, including Malaysia, remains an area where further published clinical data is beneficial. The present case, therefore, contributes important preliminary regional evidence regarding the use of BonMaker-processed autogenous dentin, building upon existing local reports [26].

While acknowledging the inherent limitations of single-case observations, comprehensive validation requires rigorously designed comparative trials. A practical and informative approach would be a randomized controlled split-mouth study involving bilateral extraction sockets. Such a model could directly compare autogenous dentin with conventional graft materials by assessing quantitative bone outcomes, primary implant stability, and long-term success rates. Emerging research is beginning to address this gap. For example, Issa et al. (2024) demonstrated comparable osseointegration between dentin-derived and bovine grafts in a sample of 40 sockets at the 12-month mark. Interestingly, their study also found that the adjunctive use of simvastatin significantly enhanced the percentage of newly formed bone [27]. To establish the full clinical value of chairside AutoBT, future investigations involving larger patient cohorts and extended follow-up periods of five to ten years will be essential to confirm its reliability, economic efficiency, and safety in routine implant dentistry.

4. CONCLUSION

This clinical report demonstrates the successful application of chairside autogenous dentin grafting (AutoBT) in reconstructing alveolar bone for immediate implant placement following trauma. By reprocessing the patient's own extracted teeth, the technique eliminated the need for a secondary donor site and took advantage of the biological activity inherent in dentin. CBCT scans obtained at intervals over a 12-month period confirmed the stability of the ridge, preservation of peri-implant bone, and marginal bone loss of less than one millimeter. Autogenous dentin satisfies several essential criteria for graft materials, including high biocompatibility, reliable osteoconductive properties, and the ability to support osteoinduction through the controlled release of bone-regenerative growth factors such as BMP-2, BMP-7, and TGF-β1. These features align with current trends in regenerative dentistry that prioritize autologous, intraoperative solutions aimed at minimizing synthetic graft use and reducing surgical waste. Although preliminary clinical results indicate that implant success with AutoBT may parallel outcomes observed with autogenous bone or xenografts, the supporting evidence remains largely confined to studies with short- to medium-term follow-up. Future research should prioritize well-controlled, long-duration trials that incorporate histomorphometric evaluation and patient-reported outcomes to validate these early findings. In the meantime, AutoBT presents a practical option for grafting contained alveolar defects, provided sufficient dentin volume is available, though its broader applicability awaits confirmation through larger-scale investigations.

5. ACKNOWLEDGEMENT

The authors would like to express their gratitude to the Medini Dental Clinic Taman Daya, Johor Bahru, for their support and for providing the clinical facilities essential for the management of the case presented. Sincere appreciation is also extended to Universiti Teknologi Malaysia (UTM) for fostering a collaborative environment that was instrumental in the development and preparation of this case report.

6. REFERENCES

[1] Sàndor, G. K. B., Kainulainen, V. T., Queiroz, J. O., Carmichael, R. P., & Oikarinen, K. S. (2003). Preservation of ridge dimensions following grafting with coral granules of 48 post-traumatic and post-extraction dento-alveolar defects. *Dental Traumatology*, 19(5), 221–227.

[2] Cecchetti, F., Germano, F., Bartuli, F. N., Arcuri, L., & Spuntarelli, M. (2014). Simplified type 3 implant placement, after alveolar ridge preservation: A case study. *Oral and Implantology,* 7(3), 80–85.

[3] Andreucci, C. A., Fonseca, E. M. M., & Jorge, R. N. (2023). A new collector device for the immediate use of particulate autogenous bone grafts. *Applied Sciences (Switzerland),* 13(20), 11334.

[4] Zkria, Abdelrahman. (2021). Applications of Nanodiamond films deposited by coaxial arc plasma deposition method. *Proceeding of International Exchange and Innovation Conference on Engineering & Sciences (IEICES),* 7, 24-25.

[5] Minetti, E., Palermo, A., Malcangi, G., Inchingolo, A. D., Mancini, A., Dipalma, G., Inchingolo, F., Patano, A., & Inchingolo, A. M. (2023). Dentin, dentin graft, and bone graft: Microscopic and spectroscopic analysis. *Journal of Functional Biomaterials,* 14(5), 272.

[6] Purwanto, B. S., Widhiyanto, L., Chilmi, M. Z., Lestari, P., Buwana, D. S., & Edward, M. (2025). Comparison between cancellous and cortical demineralized bone matrix in terms of porosity, cytotoxicity, and residual calcium: Experimental study using bovine bone. *Journal of Medicinal and Pharmaceutical Chemistry Research,* 7(3), 542–548.

[7] Dlucik, R., Orzechowska-Wylegala, B., Dlucik, D., & Bogus, K. (2023). Histological examination of tooth-derived biomaterials obtained from different devices. *Expert Review of Medical Devices,* 20(11), 979–988.

[8] Kim, Y.-K., Lee, J., Yun, J.-Y., Yun, P.-Y., & Um, I.-W. (2014). Comparison of autogenous tooth bone graft and synthetic bone graft materials used for bone resorption around implants after crestal approach sinus lifting: A retrospective study. *Journal of Periodontal and Implant Science,* 44(5), 216–221.

[9] Kim, Y.-K., Yun, P.-Y., Um, I.-W., Lee, H.-J., Yi, Y.-J., Bae, J.-H., & Lee, J. (2014). Alveolar ridge preservation of an extraction socket using autogenous tooth bone graft material for implant site development: Prospective case series. *Journal of Advanced Prosthodontics,* 6(6), 521–527.

[10] Li, J., Jin, F., Wang, R., Shang, X., Yang, P., Zhu, Y., Tsoi, J. K. H., Chan, K., & Wang, S. (2023). Guided bone regeneration in a periodontally compromised individual with autogenous tooth bone graft: A radiomics analysis. *Journal of Functional Biomaterials,* 14(4), 220.

[11] Souza, J. C. M., Escobar, M., Pimentel, I. S., Caramês, J., Teughels, W., Silva, F., & Henriques, B. (2022). Tooth-derived matrix granules for enhanced bone healing: Chemical composition, morphological aspects, and clinical outcomes. *Ceramics,* 5(4), 981–990.

[12] Brookes, Z. L. S., Bescos, R., Belfield, L. A., Ali, K., & Roberts, A. (2020). Current uses of chlorhexidine for management of oral disease: A narrative review. *Journal of Dentistry,* 103, 103497.

[13] Zhang, R., Ruangsawasdi, N., Pumpaluk, P., Yuan, Q., Peng, Y., & Seriwatanachai, D. (2023). Bone regeneration property of tooth-derived bone substitute prepared chairside for periodontal bone defects: An experimental study. *BMC Oral Health,* 23, Article 863.

[14] Hanying, L., Yunhao, M., Han, L., Dongyang, L., Weijian, Z., & Guowu, M. (2023). Osteogenic effects of partially demineralized autogenous dentin particles in implant site preservation. *Chinese Journal of Tissue Engineering Research,* 27(16), 2488–2492.

[15] Khurshid, Z., Adanir, N., Ratnayake, J., Dias, G., & Cooper, P. R. (2024). Demineralized dentin matrix for bone regeneration in dentistry: A critical update. *The Saudi Dental Journal,* 36(3), 443–450.

[16] Wu, X., Peng, W., Liu, G., Wang, S., Duan, B., Yu, J., Yang, H., & Huang, C. (2023). Extrafibrillarly demineralized dentin matrix for bone regeneration. *Advanced Healthcare Materials,* 12(12), e2202611.

[17] Abdirashit kyzy, A., Salieva, K., Zhakypbekov, A., Omurzak, E., Abdullaev, S., Kydyrbekova, A., Sulaimankulova, S., Kambarova, G., Tursunov, M., & Jorobekova, S. (2024). Synthesis of Silver Nanoparticles in Walnut Waste Extract by Pulsed Plasma Method. *Proceeding of International Exchange and Innovation Conference on Engineering & Sciences (IEICES),* 10, (pages for this paper, e.g., 60-67).

[18] Leeraphongnan, J., Kanjanamekanant, K., & Leepong, N. (2024). Chairside autogenous tooth bone graft for alveolar ridge preservation: A review. *Mahidol Dental Journal,* 44(1), 38-44.

[19] Kim, E.-S. (2015). Autogenous fresh demineralized tooth graft prepared at chairside for dental implant. *Maxillofacial Plastic and Reconstructive Surgery,* 37(1), Article 8.

[20] Picone, A., Castro, F., Falcão, A., Medina, J. G., Minetti, E., Fernandes, J. C. H., & Fernandes, G. V. O. (2024). Autogenous tooth graft biomaterial in guided bone regeneration: A comprehensive review. *Surgeries,* 5(4), 929–947.

[21] Del Canto-Díaz, A., de Elío-Oliveros, J., Del Canto-Díaz, M., Alobera-Gracia, M.-A., Del Canto-Pingarrón, M., & Martínez-González, J.-M. (2019). Use of autologous tooth-derived graft material in the post-extraction dental socket: Pilot study. *Medicina Oral, Patología Oral y Cirugía Bucal,* 24(1), e53–e60.

[22] Łobacz, M., Wieczorek, K., Mertowska, P., Mertowski, S., Kos, M., Grywalska, E., Hajduk, G., & Rahnama-Hezavah, M. (2024). Evaluation of peri-implantitis bone defect healing: Comparing the efficacy of small-particle dentin and Bio-Oss in bone density attenuation. *Journal of Clinical Medicine,* 13(16), Article 4638.

[23] Bawankar, P., Karde, P. A., Mulay, S., Pakhmode, R., Wagh, S. P., & Thote, A. (2022). Patient-centered outcome measures comparing the autogenous and allogenic bone blocks in the augmentation of deficient alveolar ridges: A pilot study. *Journal of Indian Society of Periodontology,* 26(6), 563-569.

[24] Mahendra, D. A., Bilbalqish, K., Nugraha, A. P., Cahyanto, A., Sengupta, K., Hanna, K., Meizarini, A., & Hariyani, N. (2024). Dentin-derived alveolar bone

graft for alveolar augmentation: A systematic review. *Journal of Oral Biology and Craniofacial Research*, 14(4), 395–406.

[25] Sun, H., Yin, X., Yang, C., Kuang, H., & Luo, W. (2024). Advances in autogenous dentin matrix graft as a promising biomaterial for guided bone regeneration in maxillofacial region: A review. *Medicine*, 103(34), e39422.

[26] Mulyawan, I., Danudiningrat, C. P., Soesilawati, P., Aulanniam, A., Yuliati, A., Suroto, H., Bramantoro, T., Rizqiawan, A., & Moon, S.-Y. (2021). Demineralized dentin material sponge as a guided bone regeneration. *Malaysian Journal of Medicine and Health Sciences,* 17(6), 98–101.

[27] Issa, D. R., Nassar, M., & Elamrousy, W. (2024). Immediately placed implants using simvastatin and autogenous tooth graft combination in periodontally compromised sites: A randomized controlled clinical trial. *Clinical Oral Investigations,* 28(4), 210.