Case Report

A novel approach to regenerate bone loss in an adolescent using concentrated growth factors: One-year follow-up

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Abstract

Destructive periodontal diseases are rare occurrences in the paediatric population. Moreover, the regenerative potential of the periodontal tissues and supporting structures of teeth is even rare, once irreversible damage has occurred. The aim of this paper is to discuss the regeneration of alveolar bone defect in a 14-year-old using concentrated growth factors (CGF). Following crown removal, scaling, debridement and site preparation, CGF was placed and secured in one-walled defect in the mesial side of the lower right permanent molar. The crown was replaced on to the tooth and the patient was followed up at 1, 3, 6, 9 and 12 months for clinical and radiographic evaluation. After 12 months, the radiographic evaluation revealed the defect to be filled with alveolar bone and probing pocket depth had reduced significantly. Thus, CGF can be an effective agent and can act as a potential scaffold for periodontal regeneration in adolescents with bone loss.

Keywords: Adolescents, bone loss, bone regeneration, concentrated growth factors, periodontitis

Introduction

Periodontal diseases encompass pathological conditions affecting the gingiva, cementum, periodontal ligament (PDL) and alveolar bone.[1] Though periodontal diseases are common in adults, the prevalence of periodontitis is very low in children and adolescents.[1,2] Infection of the supporting structures initiates the cascade of periodontal disease, causing destruction of the alveolar bone, which can lead to root exposure, mobility and eventually tooth loss. Once damaged, the periodontium has very limited potential for regeneration.[3]

The presence of pluripotent progenitor cells which can differentiate into PDL forming cells and osteoblast has been found to be the key towards periodontal regeneration. Growth factors play a key role and are significant mediators which initiate the migration, attachment, proliferation and differentiation of PDL cells. Platelet concentrates (PC) are a rich source of growth factors and have yielded promising results in periodontal regeneration.[4] Platelet-rich plasma (PRP) was the first-generation PC to be used. Despite having a high concentration of platelets and fibrinogen, PRP was not a popular choice due to the use of bovine thrombin for its preparation which was associated with

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life-threatening coagulopathies. The second-generation PC to be introduced was platelet-rich fibrin (PRF) by Choukron, and PRF had several advantages over PRP as it was easier to prepare to negate the need for chemical manipulation of blood.[4,5]

The third generation of PC was introduced in 2006 and is known as concentrated growth factors (CGF).[5] CGF contains more growth factors than first and second-generation PC with a harder fibrin structure. This case report describes the use of CGF to regenerate an isolated angular bone defect in a 13-year-old child.

Case Report

A 13-year-old girl reported to the department of pedodontics and preventive dentistry with the chief complaint of pain and food accumulation in the right posterior mandibular region for the past 4 days. Dental history revealed root canal treatment in that region three years ago and upon clinical examination, a stainless-steel crown was cemented onto tooth #46. Intraoral periapical radiograph confirmed the root canal treatment and the presence of an angular bone defect with respect to the mesial root of 46 with a probing pocket depth of 8 mm.

The patient was provided with oral hygiene instructions, brushing demonstration prior to intervention. Corresponding inferior alveolar nerve was anaesthetised using 2% lignocaine (2% lignocaine in 1:200,000 dilution adrenaline, Neon Laboratories Ltd. Mumbai, India), following which full-mouth supra and subgingival scaling were performed using ultrasonic scalers (Cavitron™ Bobcat™ Pro Ultrasonic scaler, Dentsply USA). The stainless-steel crown was removed using crown remover and root planing was performed using hand instruments (Gracey curettes, Hu-Friedy USA) until the removal of necrotic cementum.

CGF Preparation

A standard, disposable, two 10 mL non-anticoagulant glass tubes and a matching centrifuge device (MEDIFUGE, Silfradent s.r.l., S. Sofia, Italy) were used. About 20 mL of intravenous blood drawn from antecubital fossa of the patient was placed in the centrifuge tubes without anticoagulants and accelerated for 30 s, centrifuged at 2700 rpm for 2 min, 2400 rpm for 4 min, 2700 rpm for 4 min and 3000 rpm for 3 min, and decelerated for 36 s to stop. All these processes are adjusted automatically by 'pre-programming' the machine.

Surgical Phase

Two weeks post scaling and root planing, surgical debridement of the defect was carried out. The extraoral surface was disinfected with a povidone-iodine solution to achieve antisepsis and intraoral antisepsis was performed with 0.12% chlorhexidine digluconate rinse for 30 s. After the administration of local anaesthesia (2% lignocaine in 1:200,000 dilution adrenaline, Neon Laboratories Ltd. Mumbai, India); crevicular and vertical incisions were made, mucoperiosteal flaps were reflected and care was taken to preserve as much of the interproximal soft tissue as possible. Meticulous defect debridement and root planing for a second time were carried out using area-specific curets (Gracey curets, Hu-Friedy). However, osseous recontouring was intentionally not carried out to preserve alveolar bone.

CGF was prepared immediately and was placed into the defect and packed, following which the flap was closed with 3–0 silk sutures (Ethicon Inc. Piscataway, USA). A new stainless-steel crown was placed after 1 month with proper marginal adaptation to prevent food entrapment.

Post-operative Care

Suitable antibiotics and analgesics (500 mg amoxicillin, four times per day; and 400 mg ibuprofen, three times per day, for 5 days) were prescribed along with chlorhexidine digluconate rinses (0.12%) twice daily for 2 weeks. Sutures were removed 2 weeks post-operatively. Surgical wounds were gently cleansed with 0.12% chlorhexidine digluconate, and the patient was instructed regarding gentle brushing with a soft toothbrush. The patient was recalled at 1 month for the placement of a new stainless-steel crown and a periapical radiograph was taken to see the treatment effect. The patient was recalled at 3, 6, 9 and 12 months, probing depth and radiographs were advised at each visit. At the end of 12 months, the probing pocket depth reduced from 8 mm at baseline to 4 mm.

The post-operative periapical radiograph at 1-year follow-up showed satisfactory healing with an evident reduction in bone defect [Figure 1] and the patient was completely asymptomatic at all the recall periods, suggesting a successful treatment outcome.

Discussion

Periodontal therapy focuses primarily on the eradication of the inflammatory process, intercepting the progression of periodontal disease and to regenerate the lost periodontal tissues. Various treatment modalities have been tested for the reconstitution of bone which has been lost due to periodontitis but predictable results have been difficult to obtain.[6] The use of PC in recent years have shown that growth factors aid in periodontal regeneration and have improved the oral health-related quality of life.[5]

PRF has achieved acceptance in the past decade as it forms a durable innate fibrin matrix, which fixates platelets and growth factors and forms a conglomerate. This structure acts as a curative matrix with unique mechanical properties which makes it unmistakable from other PC.[7] It contains thrombin that results in gradual polymerisation of fibrinogen into fibrin which results in a physiologic construction that is beneficial to healing. The structural configuration of PRF with respect to cytokine

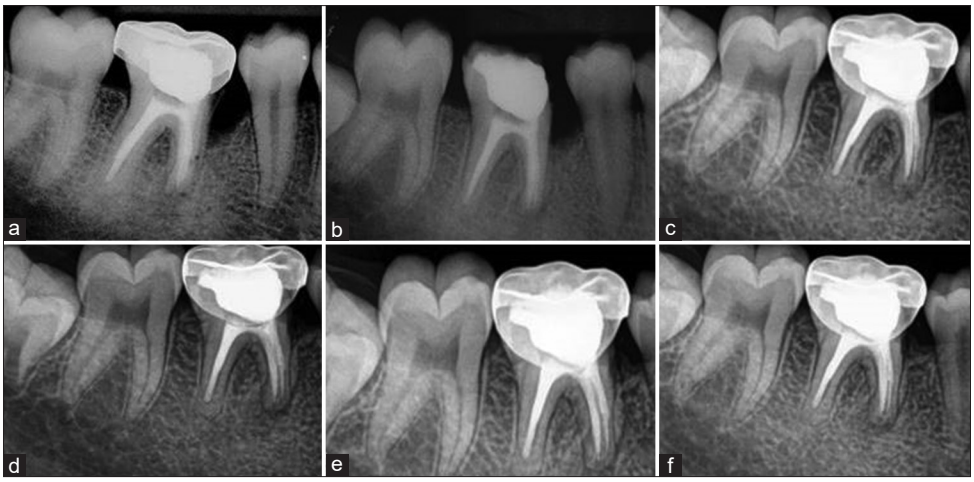

Figure 1: Radiograph. (a) Pre-operative, (b) 1 month before placement of stainless-steel crown, (c) 3 months, (d) 6 months, (e) 9 months, (f) 12 months

incorporation in fibrin meshes is different from that present in PRP.[8,9] The natural polymerisation in PRF results in an enlarged embodiment of the moving cytokines in the fibrin meshes, which have an increased lifespan and will be liberated and used only at the time of initial matrix remodelling. PRF also favours the development of microvascularisation leading to more efficient cell migration.[7] The quality of PC depends greatly on centrifugal properties which have led to the introduction of a new PC with different centrifugation speeds.[10] Sacco introduced a new PC in 2006 named CGF which was characterised by a longer and denser fibrin matrix as compared to PRF and it contained higher growth factors.[5,11] The centrifugation method for CGF is 'pre-programmed' and the resultant PC is robust, thicker and rich with growth factors. The centrifuge is armed with an oxygenating mechanism that prevents the temperature rise which helps to maintain the growth of entangled cells in the fibrin matrix.[11]

CGF provides a dense three-dimensional fibrin scaffold structure which ensures slow release of growth factors, which regulate cell proliferation and differentiation via specific receptors. Park *et al.* affirmed that CGF consisted of thicker fibrinogen fibres per area unit and regular fibrinogen structures compared to that of PRF.[12] Higher concentrations of fibrinogen, factor XIII, thrombin was reported to improve the quality of fibrin mesh formed from CGF. Further, thrombin activates the factor XIII TO XIIIa which results in increase stability of fibrin mesh, higher strength and prevents plasma mediated degradation. The fibrin mesh is reported to have high tensile and adhesive strength which could have produced results for our case.[13]

Growth factors act on target tissues and coordinate with a mixture of cellular events including cell movement, proliferation and differentiation. Rodella *et al.*[14] have ascertained that CGF addition enhanced cell proliferation of fibroblasts, endothelial cells and osteoblasts which are involved in angiogenesis, tissue remodelling and regeneration. CGF contains a higher concentration of fibrinogen, leukocytes, coagulation factors, CD34+ cells and vascular endothelial growth factors (VEGF) compared to other PC.[5,11] Transforming growth factor-beta and VEGF are known to be the representative growth factors contained in CGF that exert effects on the new bone formation or accelerate wound healing.[12]

VEGF stimulates angiogenesis, a critical point in the bone reconstruction process because the supply of blood favours osteogenesis. Angiogenesis occurs before osteogenesis but both acts symbiotically to augment bone regeneration. Since angiogenic factors play principal role in bone regeneration, VEGF plays a vital role in inducing aggregation, enrolment, propagation and differentiation. Chen *et al.* demonstrated that CGF stimulates neovascularisation which may reinforce defective angiogenic capacity and facilitate bone healing.[15,16] CGF contains approximately 1.5 times more VEGF than PRF which promotes bone formation by stimulating and accelerating other growth factors like transforming growth factor-beta and bone morphogenic protein.[12] Li *et al.*[17] investiagted the effects of CGF on proliferation of human periodontal ligament cells and found that CGf enhanced cell proliferation and mineralization and concluded that CGF was better than synthetic growth factors. Yu *et al*[18] investigated the release of cytokines from CGF and found that carriers can be used with CGF to enhance cytokine release.

Until now, there has been no reported case of CGF being used for regeneration of vertical bone defect in adolescents, and our result showed promising potential of CGF as a facilitator for bone regeneration in angular bone defects caused by periodontitis among adolescents. Further, the age of the patient and effective plaque control could play a key role in promoting the activity of CGF. The benefits of CGF are that it is autologous, can be easily prepared and cost-effective than bone grafts and membranes in extensive periapical lesions. The use of an autologous scaffold that allows sustained release of growth factors enables CGF

to be used as ideal biomaterial for bone and periodontal regeneration allowing clinicians to achieve clinical success that has not been achieved before, thus benefiting patients, parents and practioners alike. Considering the above benefits, CGF can be earmarked as an ingenious biomaterial for bone regeneration.

Conclusion

Based on the results achieved from this case report, we conclude that periodontal regeneration is possible using CGF and is an ideal biomaterial for routine clinical use in the regeneration of the bony defects in children. However, controlled clinical trials are essential to evaluate if the addition of CGF alone or in combination with bone grafts can significantly enhance bone formation and maturation.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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