

World Journal of *Clinical Cases*

World J Clin Cases 2022 November 26; 10(33): 12066-12461



Contents

Thrice Monthly Volume 10 Number 33 November 26, 2022

MINIREVIEWS

- 12066** Review of risk factors, clinical manifestations, rapid diagnosis, and emergency treatment of neonatal perioperative pneumothorax
Zhang X, Zhang N, Ren YY

ORIGINAL ARTICLE

Clinical and Translational Research

- 12077** Integrative analysis of platelet-related genes for the prognosis of esophageal cancer
Du QC, Wang XY, Hu CK, Zhou L, Fu Z, Liu S, Wang J, Ma YY, Liu MY, Yu H
- 12089** Comprehensive analysis of the relationship between cuproptosis-related genes and esophageal cancer prognosis
Xu H, Du QC, Wang XY, Zhou L, Wang J, Ma YY, Liu MY, Yu H
- 12104** Molecular mechanisms of Baihedihuang decoction as a treatment for breast cancer related anxiety: A network pharmacology and molecular docking study
Li ZH, Yang GH, Wang F
- 12116** Single-cell RNA-sequencing combined with bulk RNA-sequencing analysis of peripheral blood reveals the characteristics and key immune cell genes of ulcerative colitis
Dai YC, Qiao D, Fang CY, Chen QQ, Que RY, Xiao TG, Zheng L, Wang LJ, Zhang YL

Retrospective Study

- 12136** Diagnosis and treatment of tubal endometriosis in women undergoing laparoscopy: A case series from a single hospital
Jiao HN, Song W, Feng WW, Liu H
- 12146** Different positive end expiratory pressure and tidal volume controls on lung protection and inflammatory factors during surgical anesthesia
Wang Y, Yang Y, Wang DM, Li J, Bao QT, Wang BB, Zhu SJ, Zou L
- 12156** Transarterial chemoembolization combined with radiofrequency ablation in the treatment of large hepatocellular carcinoma with stage C
Sun SS, Li WD, Chen JL
- 12164** Coexistence of anaplastic lymphoma kinase rearrangement in lung adenocarcinoma harbouring epidermal growth factor receptor mutation: A single-center study
Zhong WX, Wei XF

Observational Study

- 12175** Prognostic values of optic nerve sheath diameter for comatose patients with acute stroke: An observational study

Zhu S, Cheng C, Wang LL, Zhao DJ, Zhao YL, Liu XZ

- 12184** Quality of care in patients with inflammatory bowel disease from a public health center in Brazil

Takamune DM, Cury GSA, Ferrás G, Herrerias GSP, Rivera A, Barros JR, Baima JP, Saad-Hossne R, Sasaki LY

- 12200** Comparison of the prevalence of sarcopenia in geriatric patients in Xining based on three different diagnostic criteria

Pan SQ, Li XF, Luo MQ, Li YM

Prospective Study

- 12208** Predictors of bowel damage in the long-term progression of Crohn's disease

Fernández-Clotet A, Panés J, Ricart E, Castro-Pocheiro J, Masamunt MC, Rodríguez S, Caballol B, Ordás I, Rimola J

Randomized Controlled Trial

- 12221** Protective effect of recombinant human brain natriuretic peptide against contrast-induced nephropathy in elderly acute myocardial infarction patients: A randomized controlled trial

Zhang YJ, Yin L, Li J

META-ANALYSIS

- 12230** Prognostic role of pretreatment serum ferritin concentration in lung cancer patients: A meta-analysis

Gao Y, Ge JT

CASE REPORT

- 12240** Non-surgical management of dens invaginatus type IIIB in maxillary lateral incisor with three root canals and 6-year follow-up: A case report and review of literature

Arora S, Gill GS, Saquib SA, Saluja P, Baba SM, Khateeb SU, Abdulla AM, Bavabeedu SS, Ali ABM, Elagib MFA

- 12247** Unusual presentation of Loeys-Dietz syndrome: A case report of clinical findings and treatment challenges

Azrad-Daniel S, Cupa-Galvan C, Farca-Soffer S, Perez-Zincer F, Lopez-Acosta ME

- 12257** Peroral endoscopic myotomy assisted with an elastic ring for achalasia with obvious submucosal fibrosis: A case report

Wang BH, Li RY

- 12261** Subclavian brachial plexus metastasis from breast cancer: A case report

Zeng Z, Lin N, Sun LT, Chen CX

- 12268** Case mistaken for leukemia after mRNA COVID-19 vaccine administration: A case report

Lee SB, Park CY, Park SG, Lee HJ

- 12278** Orthodontic-surgical treatment of an Angle Class II malocclusion patient with mandibular hypoplasia and missing maxillary first molars: A case report

Li GF, Zhang CX, Wen J, Huang ZW, Li H

- 12289** Multiple cranial nerve palsies with small angle exotropia following COVID-19 mRNA vaccination in an adolescent: A case report
Lee H, Byun JC, Kim WJ, Chang MC, Kim S
- 12295** Surgical and nutritional interventions for endometrial receptivity: A case report and review of literature
Hernández-Melchor D, Palafox-Gómez C, Madrazo I, Ortiz G, Padilla-Viveros A, López-Bayghen E
- 12305** Conversion therapy for advanced penile cancer with tislelizumab combined with chemotherapy: A case report and review of literature
Long XY, Zhang S, Tang LS, Li X, Liu JY
- 12313** Endoscopic magnetic compression stricturoplasty for congenital esophageal stenosis: A case report
Liu SQ, Lv Y, Luo RX
- 12319** Novel *hydroxymethylbilane synthase* gene mutation identified and confirmed in a woman with acute intermittent porphyria: A case report
Zhou YQ, Wang XQ, Jiang J, Huang SL, Dai ZJ, Kong QQ
- 12328** Modified fixation for periprosthetic supracondylar femur fractures: Two case reports and review of the literature
Li QW, Wu B, Chen B
- 12337** Erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+ in periodontal diseases: Two case reports and review of the literature
Tan KS
- 12345** Segmental artery injury during transforaminal percutaneous endoscopic lumbar discectomy: Two case reports
Cho WJ, Kim KW, Park HY, Kim BH, Lee JS
- 12352** Pacemaker electrode rupture causes recurrent syncope: A case report
Zhu XY, Tang XH, Huang WY
- 12358** Hybrid intercalated duct lesion of the parotid: A case report
Stankevicius D, Petroska D, Zaleckas L, Kutanovaite O
- 12365** Clinical features and prognosis of multiple myeloma and orbital extramedullary disease: Seven cases report and review of literature
Hu WL, Song JY, Li X, Pei XJ, Zhang JJ, Shen M, Tang R, Pan ZY, Huang ZX
- 12375** Colon mucosal injury caused by water jet malfunction during a screening colonoscopy: A case report
Patel P, Chen CH
- 12380** Primary malignant pericardial mesothelioma with difficult antemortem diagnosis: A case report
Oka N, Orita Y, Oshita C, Nakayama H, Teragawa H
- 12388** Typical imaging manifestation of neuronal intranuclear inclusion disease in a man with unsteady gait: A case report
Gao X, Shao ZD, Zhu L

- 12395** Multimodality imaging and treatment of paranasal sinuses nuclear protein in testis carcinoma: A case report
Huang WP, Gao G, Qiu YK, Yang Q, Song LL, Chen Z, Gao JB, Kang L
- 12404** T1 rectal mucinous adenocarcinoma with bilateral enlarged lateral lymph nodes and unilateral metastasis: A case report
Liu XW, Zhou B, Wu XY, Yu WB, Zhu RF
- 12410** Influence of enhancing dynamic scapular recognition on shoulder disability, and pain in diabetics with frozen shoulder: A case report
Mohamed AA
- 12416** Acute myocardial necrosis caused by aconitine poisoning: A case report
Liao YP, Shen LH, Cai LH, Chen J, Shao HQ
- 12422** Danggui Sini decoction treatment of refractory allergic cutaneous vasculitis: A case report
Chen XY, Wu ZM, Wang R, Cao YH, Tao YL
- 12430** Phlegmonous gastritis after biloma drainage: A case report and review of the literature
Yang KC, Kuo HY, Kang JW
- 12440** Novel *TINF2* gene mutation in dyskeratosis congenita with extremely short telomeres: A case report
Picos-Cárdenas VJ, Beltrán-Ontiveros SA, Cruz-Ramos JA, Contreras-Gutiérrez JA, Arámbula-Meraz E, Angulo-Rojo C, Guadrón-Llanos AM, Leal-León EA, Cedano-Prieto DM, Meza-Espinoza JP
- 12447** Synchronous early gastric and intestinal mucosa-associated lymphoid tissue lymphoma in a *Helicobacter pylori*-negative patient: A case report
Lu SN, Huang C, Li LL, Di LJ, Yao J, Tuo BG, Xie R

LETTER TO THE EDITOR

- 12455** Diagnostic value of metagenomics next-generation sequencing technology in disseminated strongyloidiasis
Song P, Li X
- 12458** Diagnostic value of imaging examination in autoimmune pancreatitis
Wang F, Peng Y, Xiao B

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WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

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RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Ying-Yi Yuan*; Production Department Director: *Xiang Li*; Editorial Office Director: *Jin-Lei Wang*.

NAME OF JOURNAL

World Journal of Clinical Cases

ISSN

ISSN 2307-8960 (online)

LAUNCH DATE

April 16, 2013

FREQUENCY

Thrice Monthly

EDITORS-IN-CHIEF

Bao-Gan Peng, Jerzy Tadeusz Chudek, George Kontogeorgos, Maurizio Serati, Ja Hyeon Ku

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/2307-8960/editorialboard.htm>

PUBLICATION DATE

November 26, 2022

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INSTRUCTIONS TO AUTHORS

<https://www.wjgnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjgnet.com/bpg/GerInfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>



Erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+ in periodontal diseases: Two case reports and review of the literature

Kai-Seng Tan

Specialty type: Dentistry, oral surgery and medicine

Provenance and peer review: Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): 0
Grade C (Good): C, C, C
Grade D (Fair): 0
Grade E (Poor): 0

P-Reviewer: Feng J, China; Gupta A, Nepal; Heboyen A, Armenia

Received: July 15, 2022

Peer-review started: July 15, 2022

First decision: September 25, 2022

Revised: October 5, 2022

Accepted: October 26, 2022

Article in press: October 26, 2022

Published online: November 26, 2022



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Abstract

BACKGROUND

The goal of periodontal disease treatment is to completely remove bacteria and promote wound healing. The erbium-doped yttrium aluminum garnet (Er:YAG) laser is commonly used to treat periodontal disease. Advanced platelet-rich fibrin+ (A-PRF+) secretes growth factors that accelerates soft- and hard-tissue regeneration and wound healing. Herein I present 2 cases of patients with oral diseases treated with a combination of Er:YAG laser and A-PRF+.

CASE SUMMARY

Case 1 was a female with pocket depth bone loss over 8 mm and infection of tooth 31 and 41, and severe advanced periodontitis with grade III mobility. Case 2 was a male with tooth 22 root end apical swelling and infection and alveolar bony defects. Clinical outcomes were recorded at 6 and 36 mo. In case 1, the Er:YAG laser was used to perform open flap debridement (100 mJ/pulse, 15 Hz) and remove calculus and granulation tissue (50 mJ/pulse, 30 Hz). In case 2 the laser was used to create a semilunar full thickness flap incision (80 mJ/pulse, 20 Hz) and eliminate the pathogen (100 mJ/pulse, 15 Hz). In both patients, A-PRF+ mixed with bone was used to fill bone defects, and A-PRF+ autologous membranes were used to cover tension-free primary flaps. There was no recurrent infection at 36 mo, and tissue regeneration and wound healing occurred.

CONCLUSION

Debridement with an Er:YAG laser followed by treatment with A-PRF+ is effective for the treatment periodontal diseases with bone defects.

Key Words: Erbium-doped yttrium aluminum garnet laser; Advanced platelet-rich fibrin+; Periodontology; Tissue regeneration and healing; Wound healing; Case report

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Core Tip: Combined treatment with an erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+ is effective for the management of severe periodontal disease and infection and in alveolar bone defects.

Citation: Tan KS. Erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+ in periodontal diseases: Two case reports and review of the literature. *World J Clin Cases* 2022; 10(33): 12337-12344

URL: <https://www.wjgnet.com/2307-8960/full/v10/i33/12337.htm>

DOI: <https://dx.doi.org/10.12998/wjcc.v10.i33.12337>

INTRODUCTION

The goal of periodontal disease treatment is to completely remove periodontal pathogens with surgical and/or non-surgical procedures. Conventional scaling and root planing is sufficient to remove pathogens on the teeth surface, but not in the root or cementum[1]. Thus, other methods are needed to eliminate pathogens in the root or cementum.

Phototherapy using lasers is one of the methods used to eliminate harmful substances. The erbium-doped yttrium aluminum garnet (Er:YAG) laser (wavelength 2940 nm) has a high absorption rate in water and thus a low penetration into biological tissues[2-4]. It can be used to create incisions and ablation of hard and soft tissue without thermal injury to surrounding healthy tissue[5,6]. Er:YAG lasers are used to remove periodontopathic bacteria, including *Porphyromonas gingivalis* (*P. gingivalis*) and *Aggregatibacter actinomycetemcomitans* (*A. actinomycetemcomitans*)[7,8], which can be used in periodontal pockets[9,10] and for intrabony socket debridement[11]. In addition, Er:YAG laser treatment induces blood cell attachment[12] and fibrin formation[13] to influence gingival fibroblast adhesion and proliferation of wound healing processes[14,15], and increases osteoblast proliferation to promote new bone formation[16,17].

Periodontal diseases are chronic inflammatory diseases, the tooth-support tissue damage, including atrophy or bone loss, is due to periodontal disease. The clinical measure of periodontal disease is based on bone level and clinical attachment level (CAL), and reduces probing depths (PD)[16,17]. Therefore, regeneration of damaged tooth-supporting tissue is important in periodontal disease treatment. Platelet-rich fibrin (PRF), an autologous platelet concentrates, consisted of 97% platelets and more than 50% leukocytes[18]. It secretes growth factors to promote angiogenesis, cell migration and proliferation of connective tissue[19-21], and increases the bone fill-in of bone defects area[22,23]. PRF can be modified by low speed centrifugation to form the advanced PRF and advanced PRF+ (A-PRF+)[24]. Compared with PRF, A-PRF+ releases greater amounts of growth factors that promote fibroblast migration that directly influences the wound healing process[25,26].

Based on the aforementioned findings, we hypothesized that treatment of severe periodontal disease with an Er:YAG laser to remove pathogens and dental calculus followed by application of A-PRF+ to improve tissue regeneration would provide superior results to other methods. Herein, we present 2 cases of severe periodontal disease with root infections treated with an Er:YAG laser and application of A-PRF+. After 36 mo of follow-up, there were no recurrent infections and tissue regeneration and bone formation were satisfactory.

CASE PRESENTATION

Chief complaints

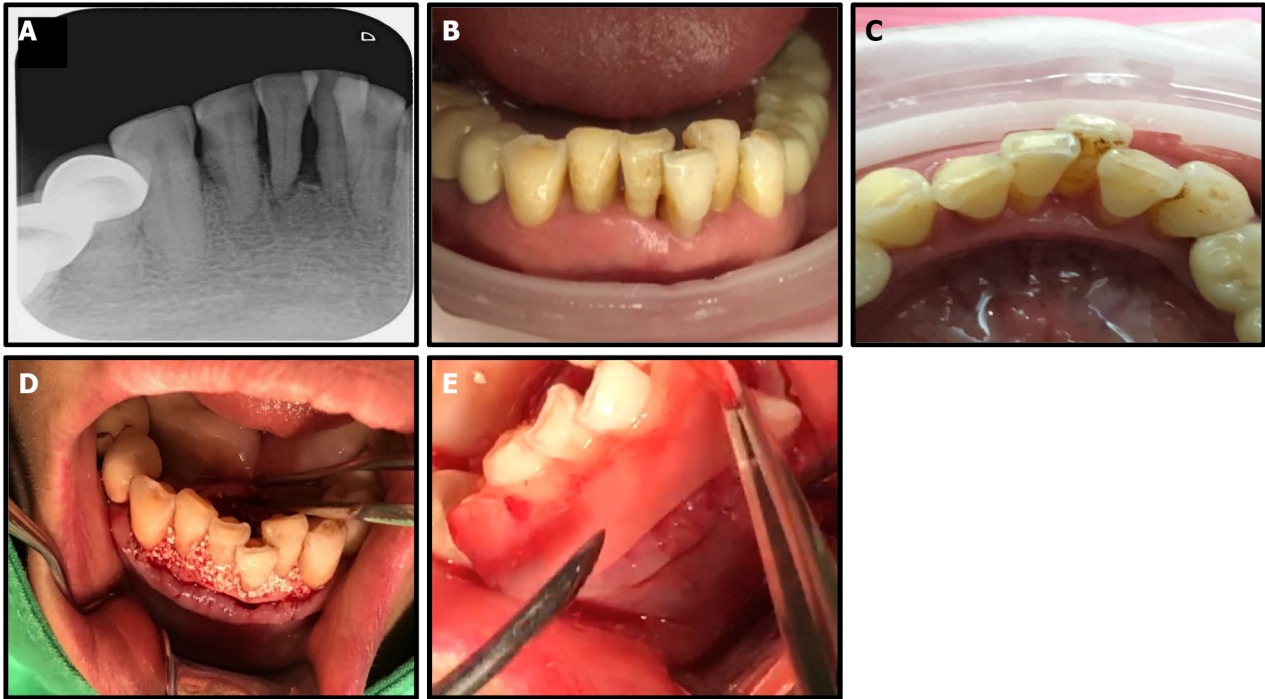
Case 1: A 54-year-old female presented with pocket depth bone loss over 8 mm and infection of tooth 31 and 41, and severe advanced periodontitis with grade III mobility (Figure 1A-C).

Case 2: A 43-year-old male patient presented tooth 22 root end apical swelling and purulent discharge (Figure 2A).

History of present illness

Case 1: The patient underwent full mouth scaling, and chlorhexidine 0.12% rinses for a week before treatment.

Case 2: The patient had received conventional apicoectomy surgery twice in a nearby general hospital 2 years prior, but swelling, pain, and other symptoms persisted. The patient received amoxicillin 500 mg and scanol 500 mg, 4 times a day, for 3 d before treatment.



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Figure 1 Combined erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+ treatment for periodontitis. A: Female patient with severe pocket depth bone loss over 8 mm of teeth 31 and 41, and advanced periodontitis; B and C: Labial and lingual appearance of the periodontium; D: The infected lesion was treated with an erbium-doped yttrium aluminum garnet laser with water spray; E: Intrabony defects were filled with allograft bone mixed with advanced platelet-rich fibrin+.

History of past illness

The patient had no significant medical history.

Personal and family history

The patient had no significant personal or family history.

Physical examination

None.

Laboratory examinations

None.

Imaging examinations

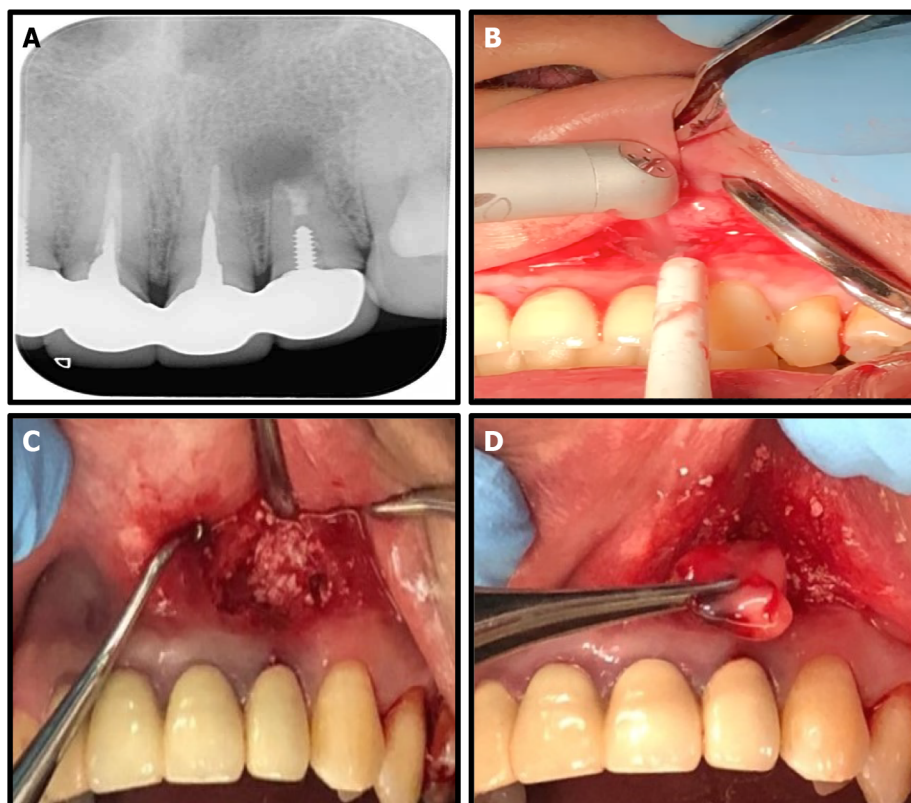
None.

FINAL DIAGNOSIS

Periodontal Diseases.

TREATMENT

Case 1: An Er:YAG laser (LiteTouch Syneron, Yokneam Elite, Israel) was used to create a full-thickness, tension-free flap with extension of the 2 adjacent teeth mesial and distally. A 17 mm chisel-shape fiber tip was used, and the laser parameters were an energy level of 100 mJ/pulse, repetition rate of 15 Hz (hard tissue/calculus removal mode). The calculus and the granulation tissue on the infected root was also removed with a 17 mm conical-shape fiber tip and the laser parameters were an energy level of 50 mJ/pulse, repetition rate of 30 Hz (soft tissue/periodontal pocket debridement mode). The granulation tissue from the healthy epithelium lining the mucosa in the periodontal pocket was vaporized, followed by decortication of the labial and lingual walls with the aid of 3 × magnification (LiteTouch Syneron, Yokneam Elite, Israel). The buccal and lingual flaps were further advanced using soft brush instruments



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Figure 2 Treatment of an alveolar bony defects with an erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+. A: Radiographic examination showed an apical lesion and bone loss (black arrow) of tooth 22; B: Infected lesions were treated with erbium-doped yttrium aluminum garnet laser with water spray; C and D: Intrabony defects were filled with allograft bone mixed with advanced platelet-rich fibrin+ (A-PRF+), and the periodontal wound was covered with double layers of A-PRF+ membranes, and then the wound was sutured.

in order to obtain a better tension-free primary closure.

A-PRF+ was prepared from autologous blood, and extraction was performed following a PRF Instrument kit protocol (Process for PRF, Nice, France). A-PRF+ liquid was mixed with particulate osseous graft material FDBA (allograft, Maxxeus, Kettering, OH, United States) to yield a moldable product, referred to as “sticky bone”. The sticky bone was harvested and compressed into intrabony defects. The labial and lingual root surfaces were covered with a double layer of an A-PRF+ membrane to promote tissue regeneration (Figure 1D and E). Tension-free primary closure was performed using an interrupted and single-sling suture techniques.

Case 2: To remove the apical purulent lesion, a semilunar full-thickness flap incision was made using the Er:YAG laser with a 17 mm chisel-shape fiber tip, set at energy level of 80 mJ/pulse, repetition rate of 20 Hz (soft tissue mode). Since an apicoectomy was done prior, to clean the pathogens the Er:YAG laser with a 17 mm conical-shape fiber tip was set at an energy level of 100 mJ/pulse, repetition rate of 15 Hz to generate a vortex shock in the cavity space *via* the laser photoacoustic effect (Figure 2B). The surgery was performed with the aid of 3 × magnification (LiteTouch Syneron, Yokneam Elite, Israel).

Sticky bone, consisting of A-PRF+ liquid and FDBA, was inserted and compressed the entire intrabony defect dead space and the periodontal wound was covered with a double layer of A-PRF+ membrane (Process for PRF, Nice, France), then the flap was sutured with simple interrupted sutures in a tension-free manner (Figure 2C and D).

OUTCOME AND FOLLOW-UP

Case 1: Occlusal reduction and tooth splinting were not detected after surgery. Periapical intraoral radiographs were obtained immediately after surgery (Figure 3A and B). At the 6 mo followed, a reduction in PD, gain in CAL, and bone fill-in of the bone defect was observed (Figure 3C and D). At 36 mo, lamina dura appearance and periodontal regeneration were noted (Figure 3E and F).

Case 2: Periapical intraoral radiographic were taken immediately after surgery (Figure 4A), and at 6 mo and 36 mo follow-up. At 6 mo there was no root end apical swelling or purulent discharge (Figure 4B).

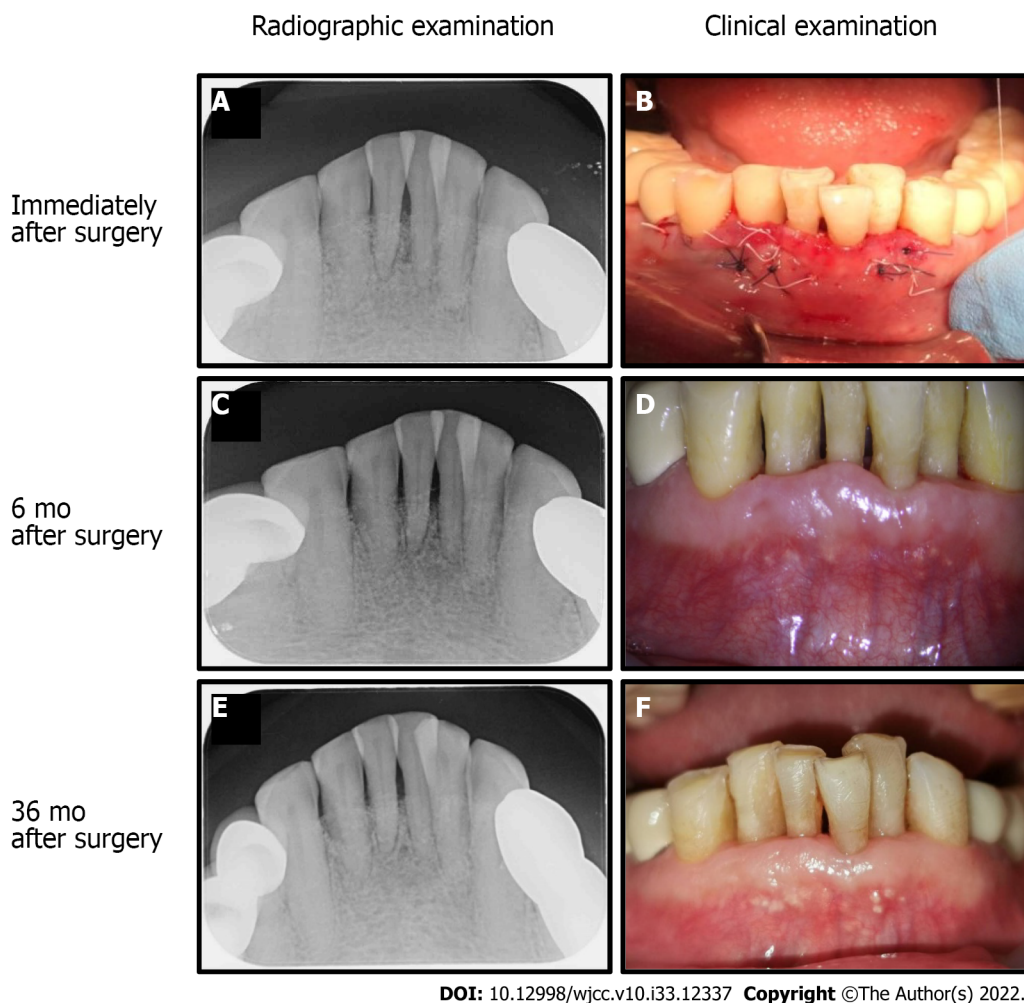


Figure 3 Evaluation of erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+ treatment in periodontitis. A and B: The radiographic and clinical examinations were taken immediately after treatment; C and D: At 6 mo after combined treatment a reduction in probing depths, gained of clinical attachment level, and radiographic evidence of bone defect fill-in was observed; E and F: Periodontal regeneration was noted at 36 mo.

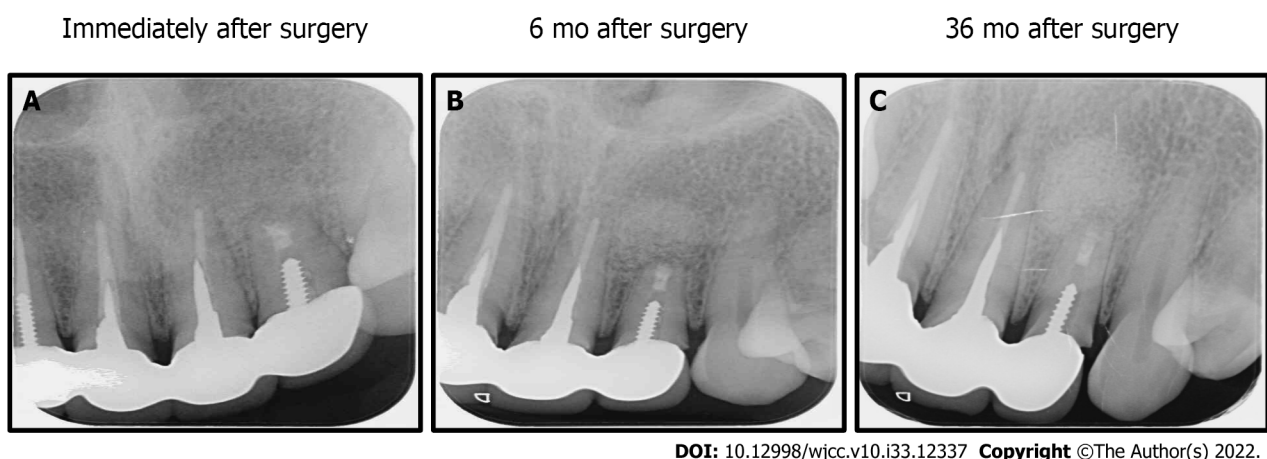


Figure 4 Evaluation of erbium-doped yttrium aluminum garnet laser and advanced platelet-rich fibrin+ treatment in alveolar bony defects. A: Periapical radiograph immediately after surgery; B: At 6 mo after surgery; C: At 36 mo after surgery. At 6 mo there was no evidence of recurrent infection of tooth 22. At 36 mo periodontal regeneration and defect bone fill-in were detected.

At 36 mo periodontal regeneration and fill-in of the bone defect were observed (Figure 4C).

DISCUSSION

The photoablative and bactericidal effects of the Er:YAG laser can eliminate the pathogens and the photobiomodulatory effects of low-level laser therapy using an Er:YAG laser promotes new bone formation[16,17]. Treatment with A-PRF+ increases tissue regeneration during the wound healing process[26]. In this study, we described the therapeutic effects of combined treatment using an Er:YAG laser and A-PRF+ for periodontitis and alveolar bony defects. The Er:YAG laser was used to remove pathogens and there was no recurrence in either patient. In case 1, a reduction in PD, gained in CAL, and defect bone fill-in were observed after 6 mo, and lamina dura appearance and periodontal regeneration were observed at 36 mo. In case 2, combined treatment resulted in tissue regeneration and no recurrence of the infection was noted at long-term follow-up. Our results suggest that combined treatment with an Er:YAG laser and A-PRF+ is effective for the management of severe periodontal disease and infection. Combined treatment is a relative “new regeneration” clinical treatment in modern dentistry.

Based on the previous studies and my clinical experience, successful Er:YAG laser therapy is based on the correct adjustment of 9 parameters[27-31]: (1) Energy delivered per pulse; (2) frequency of the pulse; (3) water control; (4) time of exposure; (5) contact or non-contact working distance; (6) angulation of the beam; (7) choice of tips; (8) fiber or non-fiber; and (9) reflected mirrors in Er:YAG laser. For the treatment of soft tissues, the general principle is low energy (mJ), high frequency (Hz), low water pressure, and relatively short time of exposure. Working distance is either contact or non-contact, and angulation of the beam at a 45-degree angle avoids excessive accumulation of energy transmission, scattering, and reflection which can cause surrounding healthy tissue damage. For treating hard tissue, a high energy (mJ), low frequency (Hz), and high water pressure are used. A greater exposure time is required, and angulation of the beam is the same as for treating soft tissues. Different tips can be used for tissue ablation or other purposes according to personal preferences. The fiber or reflected mirror surface inside the handpiece of Er:YAG laser reflects the laser energy, carbonization or damage of the reflected mirror will affect energy transmission which finally reduce the laser output efficiency.

Appropriate suture of the flap is also important for wound healing. After debridement, a precise buccal and lingual side flap should be designed and advanced to release tension in order to subsequently achieve tension-free primary closure. Adequate suture can prevent secondary infection and unexpected soft tissue ingrowth.

After open-flap debridement and treatment with Er:YAG laser, a bone-graft material needs to be applied to the intrabony defect and adjacent root surface to increase the bone level and CAL, and reduce PD[12,14,17,28]. Periodontitis and alveolar bony defects are mainly caused by anaerobic gram (-) bacteria, such as *P. gingivalis* and *A. actinomycetemcomitans*[7,8,30,32,33]. The water and air turbine effects of the Er:YAG laser during open flap surgery alter the anaerobic environment of the defect site. In addition, treatment with A-PRF+, enrich growth factors and leukocytes promote angiogenesis, provides oxygen to improve tissue regeneration, and prevention of recurrent infection[25,26].

CONCLUSION

The present clinical data show that combined treatment with an Er:YAG laser and A-PRF+ is effective for the management of severe periodontal disease and infection and alveolar bone defects. However, more clinical case evaluations are required before promoting further use of combined treatment with Er:YAG laser and A-PRF+.

FOOTNOTES

Author contributions: Tan KS participated in conception, evaluation, and writing of this case report.

Informed consent statement: Informed written consent was obtained from the patient for publication of this report and any accompanying images.

Conflict-of-interest statement: The authors declare that they have no conflict of interest.

CARE Checklist (2016) statement: The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

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Country/Territory of origin: Taiwan

ORCID number: Kai-Seng Tan 0000-0001-5077-1303.

S-Editor: Chang KL

L-Editor: A

P-Editor: Chang KL

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