ISSN 2307-8960 (online)

World Journal of *Clinical Cases*

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

Published by Baishideng Publishing Group Inc

World Journal of Clinical Cases

Contents — Thrice Monthly Volume 10 Number 33 November 26, 2022

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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

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PUBLICATION DATE
November 26, 2022

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World J Clin Cases 2022 November 26; 10(33): 12337-12344

DOI: 10.12998/wjcc.v10.i33.12337

ISSN 2307-8960 (online)

CASE REPORT

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; Heboyan 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+) secrets 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 would 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

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 secrets 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

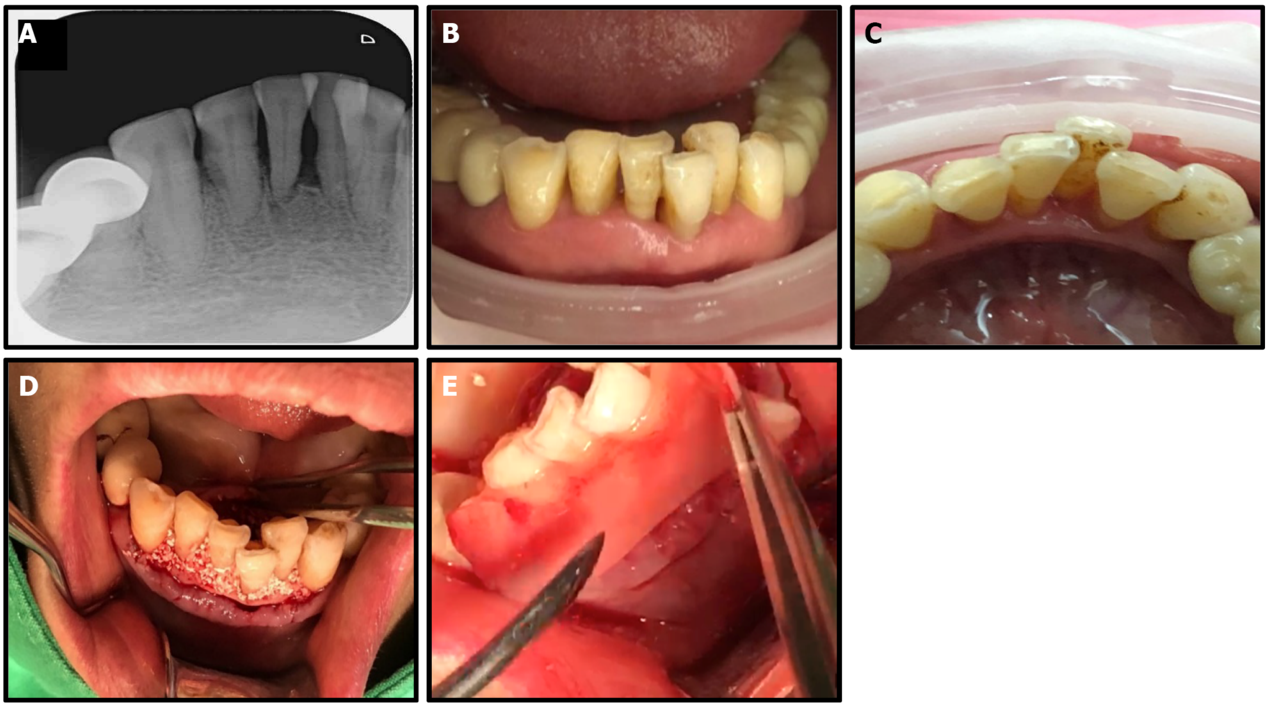
Case 1: A 54-year-old female presented with pocket depth bone loss over 8 mm and infection of tooth 31 and 41, and severe advanced periodontitis with grade III mobility (Figure 1A-C).

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.



DOI: 10.12998/wjcc.v10.i33.12337

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

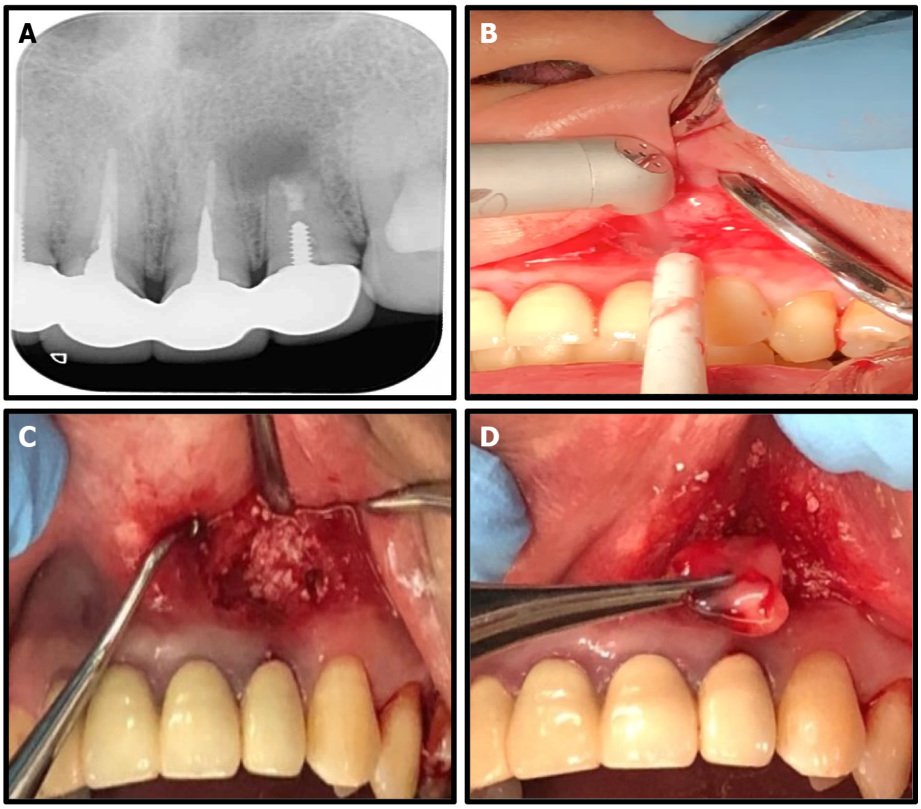
None.

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



DOI: 10.12998/wjcc.v10.i33.12337

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.

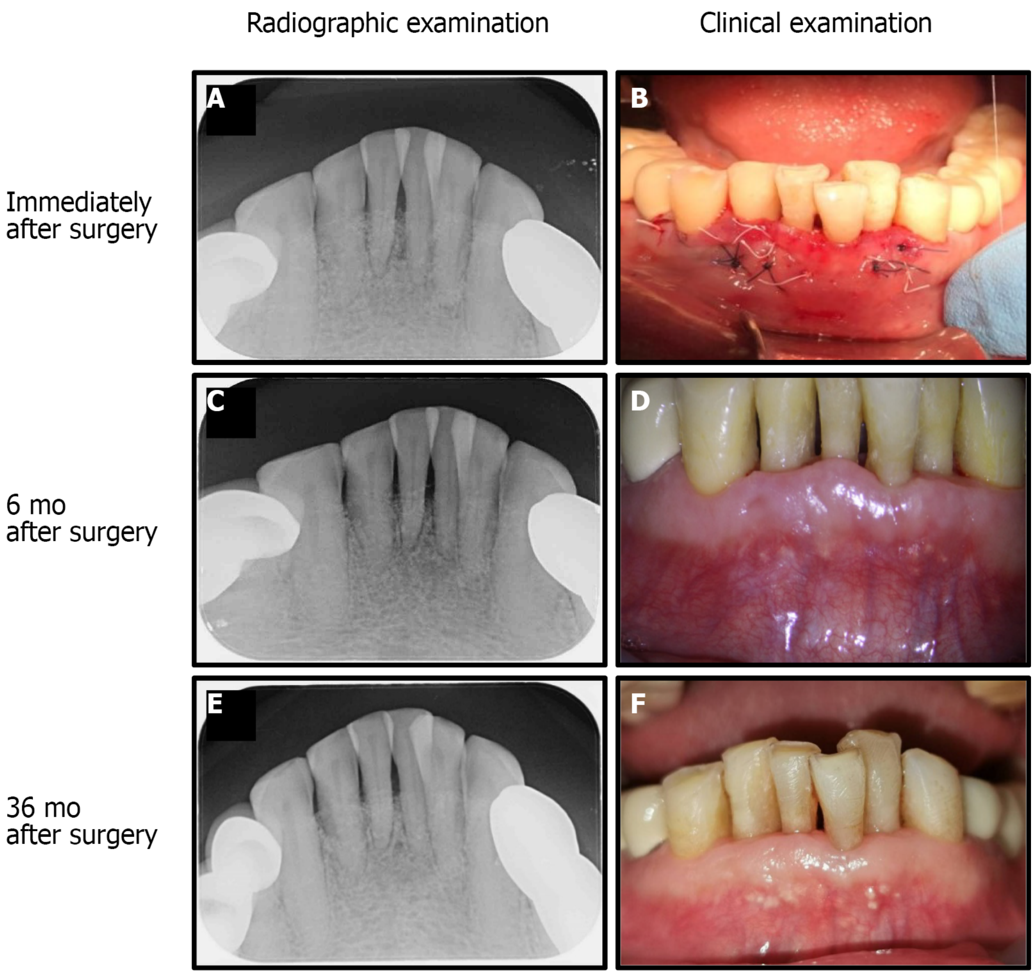
Case 2: To remove the apical purulent lesion, a semilunar full-thickness flap incision was made using the Er:YAG laser with a 17 mm chisel-shape fiber tip, set at energy level of 80 mJ/pulse, repetition rate of 20 Hz (soft tissue mode). Since an apicoectomy was done prior, to clean the pathogens the 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).



DOI: 10.12998/wjcc.v10.i33.12337

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.

DOI: 10.12998/wjcc.v10.i33.12337

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).

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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