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Gold Nanoshell-Mediated Photothermal Therapy for Facial Pores

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Facial pores are a visible topographic feature of skin surfaces and are generally the enlarged openings of pilosebaceous follicles. Enlarged facial pores can be a significant cosmetic problem, particularly for women. Recently, gold nanoshell-mediated photothermal therapy (PTT) has been reported to be effective in treating recurrent acne. The treatment of enlarged facial pores with gold nanoshell-mediated PTT produced excellent results with no side effects. The two cases reported here demonstrate the possibility of gold nanoshell-mediated PTT as a safe and effective treatment for enlarged facial pores.

Key words

Facial pores; Photothermal therapy; Gold nanoshell; Gold microparticle

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INTRODUCTION

Facial pores are a visible topographic feature of skin surfaces and are generally the enlarged openings of pilosebaceous follicles. Enlarged facial pores can be a significant cosmetic problem, especially for women.¹

There are many causes of enlarged facial pores including genetic predisposition, aging, and secondary hormonal changes in individuals, acne scars, and chronic UV exposure, yet most significant contributing factor seem to be excessive sebum secretion.¹⁻³ Many modalities targeting the sebaceous glands have been developed for the treatment of facial pores and they have been shown to induce selective necrosis of the sebaceous glands. These are photodynamic therapies (PDT), diode laser devices, and nonablative radiofrequency devices.¹

Photothermal therapy (PTT) is a kind of PDT, refers to the use electromagnetic radiation, commonly in the near infrared (NIR) wavelengths, for the treatment of various medical conditions including cancer.⁴ It is considered as the central application of plasmonic nanoparticles in medicine. Among the plasmonic nanomaterials, gold nanoparticles have received considerable attention in PTT due to their high photothermal conversion efficiency, low toxicity, easy synthesis, and functionalization, as well as their easily tuned surface plasmon resonance frequency to the NIR region.⁵

Here, we investigated the utility and safety of gold nanoshell-mediated PTT as a treatment for enlarged facial pores.

CASE REPORT

Case 1

A 25-year-old healthy female presented with facial pores and acne on her face (Fig. 1A). She wanted a proce-

dure without down time. To treat her facial pores, we tried PTT with gold nanoshells. An ampoule of gold nanoshells (3.5 ml/ampoule; Simfle-Stick. Co. Ltd, Daegu, Korea) was applied to the face and sonophoresis (Freezen RF; Medro Medical Division. Co., Ltd., Seoul, Korea) was performed for 10 minutes to increase the delivery of gold nanoshells into the hair follicles. After that we wiped off the residual superficial nanoshells from the skin surface and used a 1064-nm Nd:YAG laser (GentleMax Pro; Candela Corp., Wayland, USA). The laser parameters were fluence 6 J/cm², pulse duration 3 msec, without cooling, and 1500 shots of laser pulse were used. No topical anesthesia was applied before the laser treatment. The patient underwent two repeated sessions of PTT with an interval of 1 week. After two sessions of treatment the facial texture and acne were improved, and the enlarged facial pores were markedly reduced (Fig. 1B). The patient was very satisfied with the outcome of the treatment, and the treatment was well tolerated with no major adverse effects.

Case 2

A 26-year-old female presented with facial pores and acne on her cheeks (Fig. 2A). She had no remarkable medical history. After obtaining informed consent, we treated her with the same PTT protocol as described above. An ampoule of gold nanoshells was applied to the face and sonophoresis (Freezen RF) was performed for 10 minutes to increase the delivery of gold nanoshells into the hair follicles. After that we wiped off the residual superficial nanoshells from the skin surface and used a 1064-nm Nd:YAG laser (GentleMax Pro). The laser parameters were fluence 6 J/cm², pulse duration 3 msec, without cooling, and 1500 shots of laser pulse were used. No topical anesthesia was applied before the laser treatment. The patient underwent two repeated sessions of PTT with an interval of 1 week. The facial pores showed

Fig. 1. Clinical improvement of the facial pore and acne after gold nanoshell-mediated photothermal therapy. (A) Before the treatment, (B) after two sessions of gold nanoshell-mediated PTT.

Fig. 2. (A) Before treatment: facial pores and acne on the cheek (B) improvement of the facial pores and acne after treatment.

marked improvement without any other treatments after two sessions of PTT (Fig. 2B).

DISCUSSION

Gold nanoshell-mediated PTT facilitates the selective absorption of specially designed gold microparticles into the hair follicles and sebaceous glands using ultrasonic waves, followed by irradiation with a laser to selectively destroy them. Gold nanoshells are less likely to be absorbed by the epidermis and are more selectively absorbed by the hair follicles and sebaceous glands and hair follicles, leaving little risk of pigmentation.

The previous reports show the possibility of gold nanoshell-mediated PTT as an effective treatment for recurrent acne patients. Three sessions of PTT prevented the development of new lesions during a follow-up period of 3-4 months without causing any adverse effects. Potential advantages of gold nanoshell-mediated PTT include a lack of systemic toxicity, minimal local inflammatory side effects, efficient reduction in acne severity after a brief well-tolerated procedure, and long-lasting therapeutic benefit because of targeting sebaceous glands.⁶⁻⁸

In the study of gold nanoshell-mediated PTT, optical imaging visualized gold microparticles, which appeared as hyperreflective columns inside hair follicles that were not detected in the surrounding skin in healthy participants and acne patients. After laser exposure, reflectance confocal microscopy and histology revealed selective perifollicular tissue change.⁷ On delivery of the nanoshells into the follicles and glands, followed by wiping of superficial nanoshells from the skin surface and exposure of skin to near-infrared laser, the nanoshells localized in the follicles absorb light, get heated, and induce focal thermolysis of the sebaceous glands. The human clinical studies confirmed the efficacy of ultrasonically delivered

silica-gold nanoshells in inducing photothermal disruption of sebaceous glands without any collateral damage of the skin.⁶

We decided to treat the two patients with gold nanoshell-mediated PTT because one of the main causes of enlarged facial pores and acne is hyperactivity of sebaceous glands and gold nanoshell-mediated PTT can selectively damage sebaceous glands.

We think that gold nanoshell-mediated PTT is a very effective treatment for facial pores with little side effects. However, further studies should be conducted to evaluate the efficacy and mechanism of gold nanoshell-mediated PTT in the treatment of facial pores.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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