

Bactericidal effects of 222 nm ultraviolet light on the surgical sites in rabbits

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INTRODUCTION:

Surgical site infections are among the most severe complications associated with surgical treatment. Continuous monitoring of surgical wounds is necessary to prevent contamination by indigenous skin and airborne bacteria, which cause such infections. Although ultraviolet C (UVC) exerts bactericidal effects, it is cytotoxic. UVC, with a wavelength of 222 nm, has a high absorption coefficient for proteins and is considered safe for human use as it does not penetrate deep areas. We previously reported the non-toxic effects of 222 nm UVC irradiation on uncovered surgical sites in humans and rabbits. [1,2] However, the bactericidal effects of surgical field irradiation remain unknown. Therefore, in this study, we aimed to evaluate the bactericidal effects of 222 nm UVC irradiation on exposed surgical sites in rabbits.

MATERIALS AND METHODS:

We used 16-week-old female New Zealand white rabbits (Japan SLC, Inc., Hamamatsu, Japan) in this study. An exposed area was created on the back of these rabbits (Fig.1) and sprayed with a washing solution from a swab of both soles. The animals were divided into three groups: one exposed to 500 mJ/cm² of 222 nm UVC irradiation using a SafeZoneUVC device (Ushio Inc. Tokyo, Japan), another exposed to 200 mJ/cm² of 254 nm UVC irradiation using a low-pressure mercury lamp (FL-4Wx1; AS ONE, Osaka, Japan), and a non-irradiated group (n = 10 in each group). After irradiation, the washing solution of the swab scraped from the surgical field was cultured at 37 °C for 48 h, and the bacterial species in the resulting colonies were identified.

All animal procedures and experimental protocols were approved by and adhered to the ethical standards of the Animal Care and Use Committee of the Kobe University Graduate School of Medicine

RESULTS:

After culture at 37 °C for 48 h, the number of colonies formed in the culture dish was counted. Notably, the number of colonies was significantly reduced in both the 222 and 254 nm irradiation groups compared to that in the non-irradiated group. Moreover, no significant differences were observed between the 222 and 254 nm irradiation groups (Fig. 2). Some bacterial species were common in the colonies of both the 222 and 254 nm irradiation groups.

DISCUSSION:

Bacterial species analysis of post-irradiation colonies revealed that the bacterial strains sensitive to 222 and 254 nm UVC were different. However, the significance of the difference in the clinical setting remains unknown.

We previously confirmed the safety of 500 mJ/cm² of 222 nm UVC irradiation in a similar animal model. [2] Here, our findings revealed that 500 mJ/cm² of 222 nm UVC irradiation is as effective as 200 mJ/cm² of 254 nm UVC irradiation and exerts bactericidal effects. However, the dosage of 254 nm UVC used in the current study is lower than that clinically applied to infected pressure ulcers in the United States and Canada. [3] These results suggest 222 nm UVC irradiation as a safe and effective tool for surgical field sterilization. However, its safety and efficacy need to be validated in human clinical trials to facilitate its clinical application.

SIGNIFICANCE:

Our findings revealed the bactericidal effects of 500 mJ/cm² of 222 nm UVC on indigenous skin bacteria and its potential safety and efficacy for human use. Therefore, this irradiation can be used for the prevention of perioperative infections in the future.

REFERENCES:

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- [2] Fukui T, et al. Photochem Photobiol 2022;98:1365-1371.
- [3] Nussbaum, et al. Arch Phys Med Rehabil. 2013 Apr;94(4):650-9.

Fig. 1. Exposed area (3 x 3 cm) created on the back of the rabbits using an H-shaped incision.

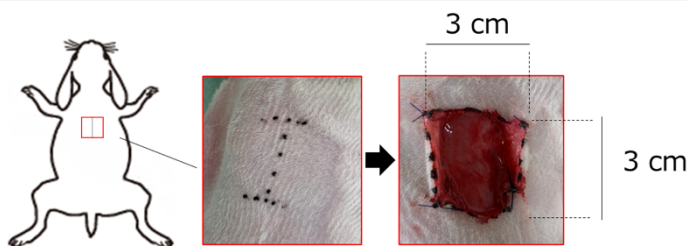


Fig. 2. Number of bacterial colonies in the washing solution culture of the swab after irradiation.

