Titan®, a light-based, skin-tightening device, was developed and is used widely in the field of non-surgical skin rejuvenation. Public interest is growing rapidly, so there is a need to scientifically evaluate the effects of Titan®. In animal experiments, Titan® irradiation was applied to rats at 15, 35, and 50 J/cm², and histological analysis was performed. In animal experiments, edema occurred in the dermis after treatment and fibroblasts producing collagen became large. The fibers thickened during the course of the animal experiments.

Introduction
Titan®, a broadband infrared light made by Cutera, Inc., was developed as a device that eliminates skin sagging by means of optical technology, unlike RF devices that eliminate skin sagging by using high-frequency radiation. Titan® utilizes a unique wavelength spectrum from 1100 to 1800 nm. It emits 30-65 J/cm² of energy at the treatment site in humans, heating at a depth of 1-3 mm.¹) The epidermis is cooled appropriately by cooling preoperatively, intraoperatively, and postoperatively, thereby maintaining the epidermis at a safe temperature below 40°C. At a wavelength of 1400-1500 nm, there is considerable absorption by water, and the top of the papillary dermis is heated. This is believed to generate collagen fiber in the top layer of the papillary dermis and also eliminate skin sagging. Therefore, in the present study, the dorsal region of rats was irradiated with Titan®, after which local intradermal changes were observed at the tissue level, and intradermal proliferation attributable to the wound healing mechanism of Titan® is discussed at the pathology level.
Methods

① Titan®-irradiated rats

Both sides of the dorsal region of rats under general anesthesia were shaved, after which groups of 18 rats were irradiated in the dorsal region, at outputs of 15, 35, and 50 J/cm². After irradiation, the animals were raised as usual.

② Skin sampling

Skin was excised from the irradiated site in 3 animals of each group, at 3 hours, 1 day, and 3 months after irradiation.

③ Histological analysis of skin samples

Paraffin sections were prepared from formalin-fixed samples and stained with HE. These [samples] were evaluated with respect to histological changes, particularly intradermal fiber components.

The intradermal changes in rats irradiated at outputs of 15, 35, and 50 J/cm² were observed over time.

Results

In the present study, the following results were obtained for all samples, 3 hours, 1 day, and 3 months after irradiation.

① Intradermal changes in rats irradiated at 15 J/cm² output (Figs. 1A, B, C)

As a result of Titan® irradiation, enlargement of fibroblasts was observed after 3 hours, but no change in fiber thickness was observed (Figs. 1B and C).

② Intradermal changes in rats irradiated at 35 J/cm² output (Figs. 2A, B, C)

As a result of Titan® irradiation, enlargement of fibroblasts was observed after 3 hours, intercellular edema occurred, and many inflammatory cells were observed (Fig. 2A). Also, the fiber thickened 3 months after irradiation (Fig. 2C).

③ Intradermal changes in rats irradiated at 50 J/cm² output (Figs. 3A, B, C)

As a result of Titan® irradiation, enlargement of fibroblasts was observed after 3 hours (Fig. 3A). Fiber changes were conspicuous after 3 months (Fig. 3C).
Discussion

Titan® is believed to manifest its effects via two main mechanisms. The first mechanism is the immediate contraction of collagen fibers exposed to a temperature exceeding 50 °C. The second mechanism is the wound healing mechanism that results from selective thermal damage. It is inferred that new collagen is generated by the wound healing mechanism, after intradermal heating damages collagen fibers. The general wound-healing mechanism consists of 3 phases: the inflammation phase, the proliferation phase, and the cicatrization phase. In the first phase (i.e., the inflammation phase), inflammatory cells (e.g., fibroblasts) are induced. In the second phase (i.e., the proliferation phase), there is active cell proliferation and active synthesis of granulation tissue, an intercellular substance. In the third phase (i.e., the cicatrization phase), a new extracellular matrix (e.g., elastin, collagen fibers) is produced by fibroblasts during tissue remodeling. It is generally said that fibroblasts induced at a wound (peaking at 48-72 hours), where they proliferate in the wound healing process, arrange themselves in the direction of tension, and synthesize and secrete collagen, elastin, etc. It also is said that collagen fibers are found as collagen fibrils one week after a wound, and they gradually become thick and dense. As a result of the Titan® irradiation of rats in the present study, fibroblast enlargement was observed (Figs. 1A, 2A, 3A); conspicuous inflammatory cells and tissue edema were observed (Fig. 2A); slight intradermal inflammation occurred; and fibroblast activation occurred; so it can be inferred to be equivalent to the inflammation phase in the general wound healing mechanism. Also, changes in fiber thickness are seen in Figs. 2C and 3C. It can be inferred that, over a long period, collagen fibers were synthesized and collagen fibers were generated by the wound healing mechanism.

Summary

From the present study, it is possible to infer that collagen fiber was generated by the wound healing mechanism for 3 months after the irradiation of rats with Titan®. Moreover, attention is being focused on the relationship between long-term intradermal changes, particularly the genesis of collagen fibers, and the continuation of the clinical skin-tightening effect after 1 year and 6 months. Future evaluation at the tissue level is believed to be necessary, to also back up its clinical efficacy.

References

