

# Monitoring the effect of noninvasive cosmetic procedures on skin photoaging

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## Abstract

**Introduction:** The human desire to slow down biological aging and conceal the external manifestations of premature aging has given rise to the pursuit of esthetic procedures. With advancing age, the structural integrity of the skin undergoes a decline, characterized by a decrease in elasticity and firmness and an increase in the number of wrinkles as a consequence of skin photoaging.

**Aim:** The aim of this study was to investigate the effect of non-invasive cosmetic procedures on skin photoaging, specifically radiofrequency lifting and facial kinesitherapy.

**Materials and methods:** The study included 100 patients. The participants were divided into two groups: control and experimental. The study was prospective and lasted six months. The Glogau scale was used to assess wrinkles at the beginning and end. The experimental group received facial muscle kinesitherapy as well as radiofrequency lifting. The control group only received procedures that involved radiofrequency lifting.

**Results and discussion:** We found a statistically significant difference regarding skin photoaging between the initial and final results in the experimental and control groups. The experimental group saw improvements in wrinkle reduction and facial contour smoothing as a result of radiofrequency lifting and kinesitherapy for the mimic muscles.

**Conclusion:** Radiofrequency lifting combined with active gymnastics of the facial muscles improves the contour, appearance, and natural vision by influencing the effects of skin photoaging.

## Keywords

kinesitherapy, photoaging of the skin, radiofrequency therapy

## Introduction

An aging population and rising life expectancy and standard of living in contemporary society have sparked a growing interest in the subject of aging. People look to improve their appearance after a certain age, in addition to feeling fit and healthy. Humanity's dreams and longings have long included health, youth, and beauty. This aspiration drives the rapid development of science and technology in cosmetology.<sup>[1]</sup>

With age, the structure of the skin changes. Elasticity, firmness, and radiance decrease, and wrinkles increase due to skin photoaging.<sup>[2]</sup> Unlike chronological aging, which is determined by the individual's physiological predisposition, photoaging depends primarily on the degree of sun exposure and the amount of melanin in the skin.<sup>[3]</sup>

Photoaging is a medical condition, and its clinical signs are reduced to the appearance of wrinkles, stretch marks, keratoses, telangiectasias, loss of elasticity, and pale color.<sup>[4]</sup> Loss of elasticity, combined with the appearance of deep

wrinkles, is a key aging problem in individuals with mature skin. Collagen and elastin levels decrease, disrupting the dermal tissue arrangement, leading to a loss of skin firmness. The skin appears less firm, and wrinkles deepen.<sup>[5]</sup> Another major factor behind the loss of firmness and deepening of wrinkles is the decrease in the production of hyaluronic acid. Produced naturally by young skin, it surrounds cells, helping them retain water. Hyaluronic acid production slows as we age, and the skin becomes drier and loses firmness and elasticity.<sup>[6]</sup>

According to Lemperle and co-authors<sup>[7]</sup>, wrinkles can be of several types. Superficial wrinkles are associated with changes in the superficial layers of the skin, specifically in the dermis, as a result of biological aging and photoaging in certain areas. Mimic wrinkles are the visible effects of deep dermal changes caused by repetitive contractions of facial muscles and facial expressions. Wrinkles in old age are mainly the result of the overlap of several factors: genetic laxity, biological aging, loss of skin and muscle tone, bone atrophy, gravity, and photoaging.<sup>[7]</sup>

The application of noninvasive cosmetic procedures, including radiofrequency lifting and kinesitherapy for the facial muscles, affects skin photoaging (wrinkle reduction).

## Aim

This study aims to monitor the effect of non-invasive cosmetic procedures on skin photoaging by applying radiofrequency lifting and facial kinesitherapy.

## Materials and methods

### Contingent clients. Characteristics

During the initial observation stage, 100 participants were chosen and divided equally into two sex and age-matched groups (experimental and control). In the experimental group, we used active gymnastics on the face muscles and

performed a radiofrequency facelift. In the control group, we carried out a radiofrequency facelift. The initial and repeat tests were carried out at the RA DERM esthetic center in Plovdiv, Bulgaria. The study has a prospective design (duration: 6 months) and is sample-based.

### Inclusion criteria

The participants had to meet the following criteria in order to be eligible: signed informed consent; age between 45 and 70 years; absence of metal prostheses or pacemakers; absence of active skin allergies; absence of open or unhealed fresh wounds; absence of infectious or malignant skin diseases; absence of dermatological procedures such as laser treatment, dermal filler injections, and botulinum toxin in the facial area within the previous three to five years; absence of surgical or plastic procedures; absence of diabetes; absence of residual neurological symptoms, either motor or sensory; and absence of accompanying psychiatric diseases for better assistance.

### Exclusion criteria

We excluded participants who did not meet the study's inclusion criteria.

## Research design and methods

Before starting the procedures, each participant was informed about the study design and signed an informed consent form. The following were assessed in all participants at the start and end of the study (at six months): age, sex, and the Glogau photoaging scale (**Table 1**).

The scale was created in 1996 by Richard G. Glogau, MD, of the Department of Dermatology at the University of California. Glogau developed a systematic classification of the types of photoaging in patients with type I being “no wrinkles,” type II – “wrinkles in emotions and motion”, type III – “wrinkles at rest”, and type IV being “only wrinkles” (**Table 1**). The idea is to organize discussions on therapies for photodamaged skin and allow rational comparisons of therapies and clinical results.<sup>[8,9]</sup>

**Table 1.** Types of photoaging according to Glogau

Type	Degree	Age	Wrinkles	Skin condition
I	light	28 - 35	Wrinkle-free	Early photo-diagnosis: mild pigment changes, lack of keratosis, minimal wrinkles on emotion, no or little makeup needed
II	moderate	35 - 50	Wrinkles when expressing emotion or movement	Early brown spots are visible, keratosis is felt but not visible, parallel smile lines are beginning to appear, and a light foundation for makeup can be applied.
III	advanced	50 - 60	Resting wrinkles	Advanced photoaging: obvious color changes, visible capillaries (telangiectasias), visible keratosis, need for heavier makeup.
IV	heavy	60 - 70	Deep wrinkles	Severe photoaging, yellow-grey skin color, possible malignant skin diseases, wrinkles everywhere – no normal skin, cannot wear makeup because the foundation cracks.

The procedure begins with applying a kinesitherapy program, which includes stretching exercises for musculus frontalis, m. corrugator supercilii, m. orbicularis oculi, and m. orbicularis oris, and isotonic exercises for m. zygomaticus, m. levator anguli oris, m. quadratus labii superioris, m. quadratus labii inferioris, and m. platysma. After completing the gymnastics for the facial muscles, radiofrequency lifting is applied, working with a unipolar RF tip in the forehead area, frown lines, crow's feet, oval, cheeks, nasolabial fold, lip contour, beard, and neck.

Initially, eight treatments were performed twice a week (for one month), and then four times a month (one procedure per week) for two months. In the period from the third to the sixth month, two procedures were performed per month. After six months, patients in the experimental group were retested. In the control group of patients, only radiofrequency lifting was performed in accordance with the above-described scheme, and the patients in this group were retested after six months.

Data from the initial study of indicators and after the sixth month were processed using the SPSS v. 23 program with the appropriate statistical methods.

## Results and discussion

The demographic factors we examined were sex and age. At the beginning of the study, we selected 72 women and 28 men, for a total of 100 participants. The average age of the clients/patients in the experimental and control groups at the beginning of the study was  $54.09 \pm 6.423$  years, with the youngest being 45 and the oldest being 68.

At the end of the study, 32 clients dropped out—11 from the experimental group and 21 from the control group. Of these, 15 (47%) were women and 17 (53%) were men. At the end of the study (after 6 months), 68 patients with a mean age of  $53.91 \pm 5.932$  years were tested. There was no significant difference in sex or mean age between participants at the start ( $54.09 \pm 6.423$  years) and end ( $53.91 \pm 5.932$  years) of the study.

In our study, we found a statistically significant difference in the photoaging indicator by sex only at the beginning of the study (Table 2).

There is no agreement in the literature on which sex exhibits more pronounced signs of skin photoaging. Frédéric et al.<sup>[10]</sup> found that photoaging affects both men and women, but the severity and characteristics of skin changes differ significantly between the sexes. Women of European descent exhibit more pronounced signs of photoaging than

men, whereas men in certain ethnic groups, such as Chinese men, may experience more subtle changes.<sup>[10]</sup>

Sex differences exist in the severity of photoaging. In general, women show more severe signs of photoaging, including deeper wrinkles and more pronounced pigmentary disorders, especially in populations of European and Northeast Asian descent.<sup>[10]</sup>

Factors influencing photoaging are related to skin phototype. Inherited skin color significantly influences the rate of photoaging, with lighter skin types being more susceptible to UV damage.<sup>[11]</sup> Environmental factors such as ultraviolet radiation, air pollution, and visible light contribute to photoaging, affecting both sexes.<sup>[11,12]</sup>

To summarize, while photoaging is a universal problem, the differences in how it manifests in men and women highlight the need for sex-specific prevention and treatment strategies.

We found a statistically significant ( $p < 0.0001$ ) high correlation ( $r_s = 0.778$ ) between the photoaging indicator and the participants' age at the beginning of the study.

These findings on the age-related relationship of skin photoaging are supported by a study by Frédéric et al., who investigated the impact of age on photoaging, including cumulative effects. The authors stated that the severity of photoaging signs, such as wrinkles and pigmentation, worsens with age, particularly in sun-exposed areas.<sup>[10]</sup> The relationship between age and skin photoaging is multifaceted, involving intrinsic and extrinsic factors. Intrinsic aging is a natural process that occurs over time, whereas photoaging is driven primarily by environmental factors, particularly UV radiation. As we age, the cumulative effects of sun exposure exacerbate the visible signs of skin aging, leading to distinct changes in the skin's structure and appearance. In particular, photoaging changes can be observed even in young adults with significant sun exposure.<sup>[13]</sup>

Using the Mann-Whitney test for two independent samples, we found a statistically significant difference in initial and final skin photoaging results between the experimental and control groups. The noninvasive procedures used, such as radiofrequency lifting and kinesitherapy for the mimic muscles, had a positive effect on smoothing the facial contour and reducing wrinkles in the experimental group (Table 3).

Research shows that noninvasive cosmetic procedures and facial muscle exercises are important in mitigating photoaging and reducing wrinkles. These methods use advanced technologies and techniques to improve skin quality and muscle tone, resulting in a more youthful appearance.<sup>[14-16]</sup>

**Table 2.** Dependence of the skin photoaging indicator and sex at the beginning and end of the study

Indicator	Men $\bar{X} \pm SD$	Women $\bar{X} \pm SD$	P
Initial Glogau photoaging score	2.43±0.573	2.90±0.675	0.001
Glogau photoaging score after 6 months	1.55±0.688	1.81±0.789	0.310

**Table 3.** Correlation of the skin photoaging indicator according to the Glogau scale between control and experimental groups at the beginning and end of the study (after six months)

Indicator	Control group $\bar{X} \pm STD$	Experimental group $\bar{X} \pm STD$	<i>p</i>
Initial Glogau photoaging score	2.80±0.639	2.74±0.723	0.565
Glogau photoaging score after 6 months	2.28±0.797	1.38±0.493	<0.0001

Gentile et al. found a 36.6% reduction in wrinkles after three months of treatment with radiofrequency therapy on facial muscles, demonstrating its efficacy in facial rejuvenation.<sup>[17]</sup>

Facial muscle exercises are very effective in improving facial contour. Studies have shown that facial exercises improve skin laxity and muscle thickness, improve facial muscle tone, and thus reduce the depth of wrinkles. Many patients report positive results with minimal side effects, suggesting a growing acceptance of these non-traditional methods.<sup>[18]</sup>

To determine whether there was a statistically significant effect of the procedures performed on the patients in the experimental group, we applied the Wilcoxon method for two related samples for the skin photoaging indicator, comparing the initial assessment with the assessment after the sixth month. We found a statistically significant difference for this indicator ( $p < 0.000$ ). We calculated the effect size  $r = 0.90$ , where  $r = Z/\sqrt{N}$ ,  $Z = -5.642$ ,  $N = 39$ , and it was found to be much larger than the typical effect size for the studied indicator.

The length of time that noninvasive procedures remain effective is associated with physiological mechanisms like antioxidant stabilization and the reduction of inflammation, both of which are essential for fighting photoaging.<sup>[19]</sup> Regularly scheduled treatments can improve skin elasticity and reduce visible signs of aging, as evidenced by improved skin conditions in participants who underwent consecutive noninvasive treatments.<sup>[20]</sup> Radiofrequency therapy effectively rejuvenates photodamaged skin, with optimal results typically seen 3–6 months after treatment.<sup>[21]</sup> The relationship between the duration of noninvasive aesthetic procedures and wrinkle reduction is significant, as longer-term treatments usually lead to more pronounced and sustained improvements in the appearance of the skin. Various non-invasive techniques effectively address signs of photoaging, such as fine lines and changes in skin texture.

## Conclusion

Elucidation of the underlying mechanisms involved in photoaging is paramount for designing specific effective therapeutic and protective strategies to improve aesthetic vision.<sup>[22]</sup> Although noninvasive procedures promise to mitigate photoaging, variability in treatment outcomes and the need for standardized protocols highlight the complexity of achieving consistent results across diverse patient demographics and skin conditions.<sup>[23]</sup> The effect of applying noninvasive aesthetic procedures to reduce skin photo-

aging is significant, as these techniques promote collagen production, skin texture, and elasticity.<sup>[24]</sup> Radiofrequency lifting, when combined with active facial muscle gymnastics, improves the contour, appearance, and natural vision of experimental group participants by influencing the effects of skin photoaging.

## Ethical approval

The Ethics Committee of the Medical University of Plovdiv granted formal approval to this study, with a favorable endorsement on February 27, 2025.

## Ethical statements

The authors declared that no clinical trials were used in the present study.

The authors declared that no experiments on humans or human tissues were performed for the present study.

The authors declared that the participants in the study gave informed consent for participation.

The authors declared that no experiments on animals were performed for the present study.

The authors declared that no commercially available immortalized human and animal cell lines were used in the present study.

## Conflict of interest

The authors have declared that no competing interests exist.

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## Use of AI

No use of AI was reported.

## Data availability

All data used are referenced or included in the article.

## Author contributions

All authors have participated in the creation of the manuscript.

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