

# Comparison the Effect of Fractional RF Laser with Microneedling on Facial Skin Rejuvenation, Open Pores and Skin Lightening: A Non-Randomized Controlled Clinical Trial

Mina Mamizadeh<sup>1</sup>, Samaneh Tahmasebi Ghorabi<sup>2</sup>, Mohammad Jamali<sup>3</sup>, Fariba Shadfar<sup>1</sup>, Arian Karimi Rouzbahani<sup>2,4\*</sup>

1. Department of Dermatology, School of Medicine, Emam Khomeini Hospital, Ilam University of Medical sciences, Ilam, Iran
2. USERN Office, Lorestan University of Medical Sciences, Khorramabad, Iran
3. School of Medicine, Ilam University of Medical Sciences, Ilam, Iran
4. Student Research Committee, Lorestan University of Medical Sciences, Khorramabad, Iran

## \*Corresponding Author:

Arian Karimi Rouzbahani

Student Research Committee,  
Lorestan University of Medical  
Sciences, Khorramabad, Iran

Tel.: +989306757977

Email: [ariankarimi1998@gmail.com](mailto:ariankarimi1998@gmail.com)

Received: 11/4/2023

Accepted: 9/3/2024

## ABSTRACT

**Background:** Effective skin rejuvenation treatments with RF technologies exist, with potential for personalized combination therapies based on individual factors. We compared microneedling and fractional RF laser effectiveness in rejuvenation, pore healing, and skin lightening.

**Method:** The research was a non-randomized clinical trial study conducted in 2021 at Ilam Skin Clinic, Ilam, western Iran on people applying for rejuvenation, skin lightening and improvement of open pores. People were voluntarily divided into two groups based on personal preferences (group A: microneedling, 25 people, group B: fractional RF, 25 people). After data collection, SPSS22 software was used for data analysis.

**Results:** The study revealed significant differences in the rates of low, moderate, and severe pain between the microneedling and fractional groups (10 vs. 16, 14 vs. 4, 1 vs. 5, respectively). Erythema showed no significant difference, with low, moderate, and severe cases reported in both groups. Swelling was lower in the microneedling group, but the difference was not significant. Bruising was similar in both groups, and staining was minimal. No herpes or infections were reported. The microneedling group showed better improvement in skin pores and skin lightening compared to the fractional group, with outcomes rated as good and excellent.

**Conclusion:** Microneedling surpassed the fractional group in skin rejuvenation, lightening, and improved pores. Considering RF lasers are approximately three times more expensive than microneedling, the research indicates that choosing microneedling is not only more cost-effective but also a superior rejuvenation technique.

## KEYWORDS

Rejuvenation; Skin's open pores; Skin lightening; Microneedling; Fractional RF

## Please cite this paper as:

Mamizadeh M, Tahmasebi Ghorabi S, Jamali M, Shadfar F, Karimi Rouzbahani. Comparison the Effect of Fractional RF Laser with Microneedling on Facial Skin Rejuvenation, Open Pores and Skin Lightening: A Non-Randomized Controlled Clinical Trial. World J Plast Surg. 2024;13(1):16-23.  
doi: 10.61186/wjps.13.1.16

## INTRODUCTION

The skin, which covers the whole body's exterior and acts as a first-order physical barrier against the environment, is the largest and most important organ for protection. Its duties include controlling body temperature and guarding against pathogens, microbes, poisons, trauma, and ultraviolet (UV) light. In addition, the skin is involved in immunologic monitoring, sensory perception, the regulation of insensible fluid loss, and overall homeostasis. Additionally, the skin is quite adaptable, having varying thicknesses and specific roles in various bodily areas<sup>1-3</sup>. Age-related loss of function and appearance is caused by both extrinsic and intrinsic chronological aging of the skin. A prolonged exposure to UV light causes photoaging, which is primarily responsible for skin aging. Histologically, a thinner epidermis, a drop in collagen, the deposition of aberrant elastic fibers, and vascular ectasia are indicative of photoaging<sup>4</sup>. Apoptosis and inflammation are thought to be the two main indicators of photoaging. Aging causes an increase in matrix metalloproteinases, which in turn accelerates the breakdown of type I and type III collagen fibers in the extracellular matrix at the molecular level<sup>5</sup>.

Aging skin has a disgusting appearance that can be summed up as follows. Prominent clinical indicators of aging facial skin are striae and rhytides. Fine and coarse wrinkles on the frontal, periocular, and nasolabial areas can appear more quickly as a result of photodamage and facial emotions. As people age, more extra epidermal pigmentation accumulates on their skin, leading to skin discolorations like age spots and melasma. Further, the appearance of skin fragility and laxity after bariatric surgery and childbirth is a frustrating issue. Post-inflammatory hyperpigmentation (PIH) and permanent scar formation are secondary conditions that can also negatively impact facial aesthetics, such as acne scars. People appear considerably older than they actually are due to these skin changes<sup>6</sup>. The prevalence of skin hyperpigmentation problems affects people's quality of life and is associated with social and cultural significance, which drives up demand for cosmetic lightening treatments<sup>7</sup>.

The procedure of skin lightening involves the use of chemicals to lower the amount of melanin in dark skin areas in order to balance out tone or, in certain situations, to obtain a lighter complexion overall.

Whitening one's skin is a long-standing practice that dates back to 200 BCE<sup>8</sup>.

Ever since this historical period, skin whitening has remained a popular procedure. Today, soaps, pills, injections, OTC and prescription creams, and a variety of cosmetic surgeries can do this. Dangerous skin bleaching without competent counseling has turned into a public health emergency, according to the WHO<sup>9</sup>. The goal of the skin rejuvenation process is to reduce the indications of aging by utilizing a combination of bio-revitalization techniques, skin-strengthening measures, and lifestyle modifications. The demand for noninvasive skin rejuvenation techniques is rising, and plastic surgeons need to be highly skilled in implementing new methods and tools in a safe and effective manner<sup>10</sup>.

Early in the new millennium, advancements in the field of fractional laser ablation (AFL) in medicine made it possible to administer skin treatments using a system of vertical columns that penetrate both the dermis and the epidermis, referred to as microthermal treatment zones (MTZs)<sup>11</sup>. These MTZs have diameters and depths that depend on the settings of the laser used. What makes this method unique is that the undamaged skin in the vicinity of the MTZ creates a reservoir of living tissue that allows the regrowth of the epidermis and the lost dermis. Also, skin penetration by fractional lasers leads to the formation of new and regenerated collagen by the surrounding fibroblasts, and also tightens the existing collagen, which helps to fill wrinkles and reduce and improve skin color. In general, the results of fractional laser therapy compared to old lasers cause faster recovery, less damage and less side effects<sup>12</sup>.

Radio frequency (RF) is a non-ionizing electromagnetic radiation that has been used in medicine for nearly 100 years. Unlike most lasers that target specific chromophores, RF works independently of the chromophore, allowing for higher skin penetration and a safer treatment for darker skin types<sup>13,14</sup>.

Thermolytic treatments with RF devices for skin rhytids, wrinkles, acne and acne breakouts have been used in many skin beauty clinics. RF devices cause tissue regeneration with neo-collagenization. The electronic currents of RF devices cause heating of the target tissue depending on the impedance of the tissue, which is known as electrical thermal reaction<sup>15</sup>. Collagen induction therapy, or microneedling (MN),

is a procedure that involves repeatedly puncturing the skin with sterile microneedles. Its inception dates back to 1995, when Orentreich and Orentreich created the notion of “subcision,” or the process of mending wounds in depressed cutaneous scars with hypodermic needles. MN provides a minimally invasive, reasonably priced therapy option for a variety of dermatological and cosmetic disorders<sup>16</sup>. Microneedling is a physically demanding and invasive procedure that stimulates platelet growth factors to increase the production of collagen and elastin while allowing new blood vessels and collagen fibers to penetrate the floor of acne scars by creating microscopic wounds in the skin with small Dermapen® needles. In this manner, stem cells are activated, allowing for the skin to repair in a safe and natural manner<sup>17</sup>. When platelets and neutrophils are attracted, growth factors like TGF-alpha, TGF-beta, and platelet-derived growth factor (PDGF) are released, initiating the natural wound healing cascade. Fibroblasts eventually deposit collagen as a result of this<sup>16</sup>.

Numerous MN products have been created to address wrinkles and scars, promote skin renewal, and enhance the appearance of the skin<sup>18</sup>.

Microneedling is a suitable treatment method to protect the skin due to less damage. It also results in much less epidermal damage than lasers and a lower risk of discoloration and scarring with microneedling, making it a good option for treating people with thin or sensitive skin (skin types > III). The design and composition of these drug-assisted microneedles are classified into four categories: solid microneedles used for skin pretreatment, drug-coated microneedles, soluble or degradable microneedles, and hollow microneedles, which could provide future treatments for multiple skin diseases and be more effective with minimal side effects<sup>19</sup>.

Skin rejuvenation is a common request among patients and a strong driver for the development of new energy-based devices in the skin. There are many ways to rejuvenate the skin. Patients prefer skin rejuvenation methods with few treatment sessions, minimal downtime, no side effects and lasting results. Extensive research has been conducted on radiofrequency (RF) based skin tightening due to its non-invasive, tolerable and effective mechanism. There are different RF technologies for skin rejuvenation. Effective skin rejuvenation treatments have been achieved with RF technologies, but there is more potential in combination treatments that can

be tailored to patients according to their specific skin types, skin conditions, and patient preferences.

In this study, the effect of microneedling and fractional RF laser on rejuvenation, improvement of pores and skin lightening were compared.

## MATERIALS AND METHODS

### Study design

This study is a non-randomized clinical trial conducted after obtaining ethics approval from the Ethics Committee of Ilam University of Medical Sciences (IR.MEDILAM.REC.1400.154). It was registered in the Iran Clinical Trial System (IRCT20211212053366N1). The study was conducted in the skin clinic of Ilam city, Iran in 2021.

### Study inclusion and exclusion criteria

- Inclusion criteria: Participants were included in the study with the following criteria: desire to participate in the research, age range 20-50 years, absence of inflammatory skin disease, absence of history of psychiatric diseases, absence of history of frequent herpes, no history of keloid formation, no background diseases such as diabetes and rheumatic diseases, no history of treatment with microneedling and fractional RF laser methods.
- Exclusion criteria: People who did not cooperate to conduct the study and did not wish to continue treatment, failure to follow up treatment sessions, simultaneous use of drugs that affect the skin and perform other methods of rejuvenating and removing spots and wrinkles such as mesotherapy and fat injection and having active acne.

### Sample size and sampling method

The sample volume was calculated based on the formula  $n = \left[ \frac{Z_{1-\alpha}^2}{2} + Z_{1-\beta}^2 \right] \cdot \left[ \frac{1}{p(1-p)} \right]$ . In this study, 50 people who visited the skin clinic in 2021 who applied for skin rejuvenation, removal of open skin pores and skin lightening by microneedling or fractional RF laser participated in this study. The choice of treatment method was voluntary due to ethical considerations.

### Intervention

People were divided into two groups of 25 people

based on personal and voluntary preferences: Group A (n=25) was treated with microneedling device and Group B (n=25) was treated with fractional RF device.

Group A: Microneedling was performed by Amiya machine during 3 treatment sessions with one month intervals. In this way, the people's skin was first cleaned with an alcohol pad and serum, and then the depth of penetration of the needles was adjusted according to the people's skin, and all areas were subjected to microneedling until spot bleeding occurred in the area. It took about 20 minutes.

Group B: Fractional RF laser was performed by Unix machine in 3 sessions with one month intervals. First, the skin was cleaned with an alcohol pad and serum, then the degree of the device was adjusted according to the people's skin, and the entire half of the people's face was subjected to the laser so that the entire skin was exposed to light.

Microneedling and fractional RF were performed by a dermatologist. A total of 3 treatment sessions were performed for each person with a gap of one month between sessions.

### Outcome measures

The primary results were evaluated by personal information data collecting form (age, sex, employment status) and effectiveness (open skin pores, rejuvenation and skin lightening). The dermatologist used a researcher-made questionnaire with poor, average, good and excellent scales to measure the effectiveness.

Afterwards, the peoples were evaluated based on the researcher's checklist, which included pain, erythema, bruising, swelling, spotting, infection, and cold sores.

### Follow up Participants

The general follow-up period of the peoples was three months after the intervention. peoples were evaluated and compared in terms of the effectiveness of microneedling and fractional RF laser in skin rejuvenation, open skin pores and skin lightening three months after the intervention.

### Statistical Analysis

Data analysis was done using SPSS software

version 22 (IBM Corp, Armonk, New York) at a significance level of 0.05 (confidence interval was 95%). For quantitative data, descriptive statistics such as the mean and standard deviation were utilized, whereas frequency and percentage were used for qualitative variables. Chi-square test was utilized to evaluate the efficiency of the RF laser and microneedling groups.

## RESULTS

The average age of the participants was  $36.4 \pm 8.97$  yr in the age range (21-56) years. The majority of the subjects studied were women (90%). Overall, 78% of the participants were married. The rate of complications was measured in the two groups of microneedling and RF laser. The amount of pain in the two studied groups of microneedling and fractional RF laser was respectively (10 vs. 16), moderate (14 vs. 4) and severe (1 vs. 5), and this significant difference was reported ( $P < 0.05$ ). In terms of other complications (bruising, erythema, spots, swelling), there was no significant difference between participants treated with microneedling and RF laser ( $P < 0.05$ ). The frequency and percentage of side effects of the two groups treated with microneedling and fractional are given in Table 1. In both study groups, no infections and cold sores were reported after treatment.

The results of the effects of microneedling and RF in skin rejuvenation are given in Table 2. The effect of microneedling on skin rejuvenation was greater than the fractional effect in both good and excellent ranges, respectively good (56% vs. 36%) and excellent (28% vs. 24%). But this difference in the effect of two methods on skin rejuvenation was not statistically significant ( $P = 0.24$ ).

Based on Table 3, the effect of microneedling in the healing of skin pores was more than fractional in the excellent range, and in the good range, the effect of fractional was reported to be better than microneedling. But statistically, this difference in the effect of treatment methods on the improvement of skin pores was not significant ( $P = 0.53$ ).

The effect of microneedling on skin lightening is better than fractional, and in the medium range (15 vs. 12), the highest frequency of effect has been reported. There was no significant difference in the effect of treatment methods on skin lightening (Table 4).

**Table 1:** Frequency and percentage of complications in two groups treated with microneedling and fractional

Complications		Group	
		Microneedling N (%)	Fractional N (%)
pain	Low	10(40)	16(64)
	medium	14(56)	4(16)
	severe	1(4)	5(20)
Erythema	Low	16(64)	9(36)
	medium	7(28)	14(40)
	severe	2(8)	2(8)
swelling	Low	21(84)	19(76)
	medium	3(12)	5(20)
	severe	1(4)	1(4)
spots	Low	25(100)	24(96)
	medium	0(0)	1(4)
	severe	0(0)	0(0)
bruising	Low	24(96)	24(96)
	medium	1(4)	1(4)
	severe	0(0)	0(0)

**Table 2:** Comparison of the effectiveness of microneedling and fractional RF laser in skin rejuvenation

Effectiveness in the rejuvenation	Group		P
	Microneedling N(%)	Fractional N(%)	
Weak	1(4)	1(4)	0.24
Medium	3(12)	9(36)	
Good	14(56)	9(36)	
Excellent	7(28)	6(24)	

**Table 3:** Determining the effectiveness of microneedling and fractional RF laser in healing open skin pores

Effective in healing open skin pores	Group		P
	Microneedling N(%)	Fractional N(%)	
Weak	3(12)	5(20)	0.53
Medium	4(16)	7(28)	
Good	5(20)	3(12)	
Excellent	7(28)	6(24)	

**Table 4:** Determining the effectiveness of microneedling and fractional RF laser in skin lightening

Effect on skin lightening	Group		P
	Microneedling N(%)	Fractional N(%)	
Weak	3(12)	7(28)	0.53
Medium	15(60)	12(48)	
Good	4(16)	4(16)	
Excellent	3(12)	2(8)	



## DISCUSSION

The term “skin aging” refers to alterations to the skin brought on by aging. As the skin acts as a barrier between the human body and the outside world, it is always changing according to environmental factors as well as historical events. Therefore, depending on the epidemiological variables influencing the aging process of the skin, skin can be classified as intrinsic or extrinsic. Intrinsic aging is associated with chronological and genetic factors, whereas extrinsic aging is impacted by environmental factors <sup>20</sup>. The skin, especially the skin of the face, is exposed to environmental stress such as air pollution and the sun’s ultraviolet rays, which cause an increase in reactive oxygen species that cause severe damage to cellular structures. In this study, which was conducted with the aim of comparing the effects of microneedling and fractional RF laser on rejuvenation, improvement of skin pores and skin lightening.

The number of people included in the study was a total of 50 people, who were in two groups of 25 people treated with microneedling and Fractional RF lasers were placed. The average age of the people was  $36.4 \pm 8.97$  in the age range (21-56) years. In Chun’s study, the average age of the studied patients who used a combination of fractional radio frequency with microneedling and thulium laser for facial rejuvenation was 58.25 years <sup>21</sup>. In the study by Nilfroushzadeh et al, the average age was 51.9 years <sup>22</sup>. The results showed that the average age of the patients to receive rejuvenation, skin lightening and open skin pores services in this study was lower than other studies, and the possible reasons can be mentioned that the majority of patients in other studies performed the services Different treatment. In this study, severe pain was reported less in the microneedling group than in the fractional group, it should be noted that most people in both study groups reported low pain. Severe erythema was reported in 4 cases in both study groups. In another study, no side effects were observed. It was not reported and the pain was minimal <sup>21</sup>. Erythema was observed in 3 patients treated with laser in a study <sup>23</sup>. In both study groups, no cold sores and infections were reported.

The results of the study showed that microneedling had a better effect than fractional in rejuvenating, brightening the skin and opening skin pores on

a good and excellent scale, and these differences were not statistically significant. The effect of microneedling in the healing of skin pores was more than fractional in the excellent range, and in the good range, the effect of fractional was reported to be better than microneedling. But statistically, this difference in the effect of treatment methods on the improvement of skin pores was not significant. In another study conducted by researchers, all patients were very satisfied with the results. The results of the study showed that the combination of microneedling fractional radiofrequency and fractional minimally-invasive thulium laser was safe and effective, and produced synergistic results in skin rejuvenation in the Asian skin type which were judged to be better than either system used on its own <sup>21</sup>. In the study by Nilfroushzadeh et al <sup>22</sup>, pores and skin spots were significantly reduced. Also, TEWL decreased significantly (18.44). Meanwhile, skin density increased significantly (44.41% (R7)). Ultrasound evaluation showed that the density and thickness of the dermis and epidermis increased. The changes in other parameters were not significant <sup>22</sup>.

The results of a study showed that the clinical evaluation revealed a substantial decrease in periorbital wrinkles and dyschromia ( $P < 0.05$ ) and a significant improvement in the appearance of the face with both procedures, with no discernible differences between the two approaches <sup>24</sup>. Furthermore, there was no statistically significant difference in the patients’ substantial pleasure with both methods. Both groups’ mean TEWL and CRRT values declined dramatically, with no variation between them. On the side that had microneedling, the recovery period was noticeably shorter. After therapy using both approaches, there were no severe or enduring side effects <sup>24</sup>. The Robati study and the current study differ in a few ways. Firstly, the Robati study <sup>24</sup> involved 32 patients and the use of a fractional Er:YAG laser; this could be the reason the two methods produced similar results in terms of wrinkle removal and rejuvenation.

According to a study, fractional RF treatment was more beneficial for the perioral, nasolabial, and jawline areas, whereas fractional Er:YAG laser was more helpful for the periorbital area. Between the two treatment groups, there was no statistically significant difference in side effects <sup>25</sup>. In conclusion, both modalities significantly improve skin wrinkles; however, it should be considered that there may

be regional differences between the treatment outcomes of them<sup>25</sup>.

## CONCLUSION

The fractional group experienced more bruising, swelling, erythema, pain, and spot formation than the microneedling group did, and neither group displayed any signs of infection or herpes. Microneedling outperformed the fractional group in terms of skin rejuvenation, skin lightening, and improved skin pores. Taking into account that RF lasers are roughly three times more expensive than microneedling, the study's findings indicated that opting for the microneedling approach is not only more cost-effective but also a superior rejuvenation technique.

The thesis was financially supported by the principal investigator.

## ACKNOWLEDGEMENT

We thank all participants in the study and Ilam University of Medical Sciences. The authors also thank the Clinical Research Development Unit of Emam Khomeini Hospital, Ilam. The principal investigator provided financial support for this study.

## CONFLICT OF INTEREST

There are no conflicts of interest in terms of the present manuscript.

## REFERENCES

1. Maranduca MA, Branisteanu D, Serban DN, et al. Synthesis and physiological implications of melanic pigments. *Oncol Lett* 2019;**17**(5):4183-7. doi: 10.3892/ol.2019.10071.
2. Someya T, Amagai M. Toward a new generation of smart skins. *Nat Biotechnol* 2019;**37**(4):382-8. doi: 10.1038/s41587-019-0079-1.
3. Yousef H, Alhajj M, Sharma S. Anatomy, Skin (Integument), Epidermis. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2023, StatPearls Publishing LLC.; 2023. PMID: 29262154.
4. Sachs DL, Varani J, Chubb H, et al. Atrophic and hypertrophic photoaging: clinical, histologic, and molecular features of 2 distinct phenotypes of photoaged skin. *J Am Acad Dermatol* 2019;**81**(2):480-8. doi: 10.1016/j.jaad.2019.03.081.
5. Shin J-W, Kwon S-H, Choi J-Y, et al. Molecular mechanisms of dermal aging and antiaging approaches. *International journal of molecular sciences* 2019;**20**(9):2126. doi: 10.3390/ijms20092126.
6. Lyu J-J, Liu S-X. Radiofrequency in facial rejuvenation. *International Journal of Dermatology and Venereology* 2022;**5**(02):94-100.
7. Cheng A-D, De La Garza H, Maymone MB, et al. Skin-Lightening Products: Consumer Preferences and Costs. *Cureus* 2021;**13**(8). doi: 10.7759/cureus.17245.
8. Iftekhhar N, Zhitny VP. Overview of skin bleaching history and origins. *Dermatology* 2021;**237**(2):306-8. doi: 10.1159/000509727.
9. Vijaya RM. Dangerous skin bleaching has become a public health crisis. Corporate marketing lies behind it. *The Washington Post* 2019.
10. Tanha A, Rabiee M, Rostami A, Ahmadi S. A green-based approach for noninvasive skin rejuvenation: Potential application of hyaluronic acid. *Environ Res* 2023;116467. doi: 10.1016/j.envres.2023.116467.
11. Zhang S, Duan E. Fighting against skin aging: the way from bench to bedside. *Cell Transplant* 2018;**27**(5):729-38. doi: 10.1177/0963689717725755.
12. Yoon JH, Kim J, Lee H, et al. Laminin peptide YIGSR induces collagen synthesis in Hs27 human dermal fibroblasts. *Biochem Biophys Res Commun* 2012;**428**(3):416-21. doi: 10.1016/j.bbrc.2012.10.070.
13. Chen C-L, Liou S-F, Chen S-J, Shih M-F. Protective effects of Chlorella-derived peptide on UVB-induced production of MMP-1 and degradation of procollagen genes in human skin fibroblasts. *Regul Toxicol Pharmacol* 2011;**60**(1):112-9. doi: 10.1016/j.yrtph.2011.03.001.
14. Kim MS, Oh GH, Kim MJ, Hwang JK. Fucosterol inhibits matrix metalloproteinase expression and promotes type-1 procollagen production in UVB-induced HaCaT cells. *Photochem Photobiol* 2013;**89**(4):911-8. doi: 10.1111/php.12061.
15. Banihashemi M, Nakhaeizadeh S. An introduction to application of platelet rich plasma (PRP) in skin rejuvenation. *Reviews in Clinical Medicine* 2014;**1**(2):38-43. doi: 10.17463/RCM.2014.01.001.
16. Iriarte C, Awosika O, Rengifo-Pardo M, Ehrlich A. Review of applications of microneedling in dermatology. *Clin Cosmet Investig Dermatol* 2017:289-98. doi: 10.2147/CCID.S142450.
17. Mamizadeh M, Jowzi M, Tahmasebi Ghorabi S, Hosseini SH, Khorshidi A, Karimi Rouzbahani A. Comparing of the effectiveness and patients satisfaction in employing two approaches of Subcision and microneedling with Subcision and laser CO2 fractional in the treatment of acne scar. *Journal of Pakistan Association of Dermatologists*

- 2023;**33**(2):499-506.
18. McCrudden MT, McAlister E, Courtenay AJ, González-Vázquez P, Raj Singh TR, Donnelly RF. Microneedle applications in improving skin appearance. *Exp Dermatol* 2015;**24**(8):561-6. doi: 10.1111/exd.12723.
  19. Draelos ZD. *Cosmetic dermatology: products and procedures*: John Wiley & Sons; 2022.
  20. Wong QYA, Chew FT. Defining skin aging and its risk factors: a systematic review and meta-analysis. *Sci Rep* 2021;**11**(1):22075. doi: 10.1038/s41598-021-01573-z.
  21. Chun S. Fractional microneedling radiofrequency and fractional 1927 nm thulium laser treatment offer synergistic skin rejuvenation: a pilot case series. *Laser Therapy* 2018;**27**(4):283-91. doi: 10.5978/islm.27\_18-OR-26.
  22. Nilforoushzadeh MA, Alavi S, Heidari-Kharaji M, et al. Biometric changes of skin parameters in using of microneedling fractional radiofrequency for skin tightening and rejuvenation facial. *Skin Research and Technology* 2020;**26**(6):859-66. doi: 10.1111/srt.12887.
  23. Khanali S, Pedram A, Poorolajal J. Comparison of the efficacy of fractional CO2 laser with microneedling in management of patients with atrophic acne scars: a single-blind clinical trial. *Dermatology and Cosmetic* 2021;**11**(4):282-91. URL: <http://jdc.tums.ac.ir/article-1-5494-en.html>
  24. Robati RM, Hamedani B, Namazi N, Niknejad N, Gheisari M. Efficacy of microneedling versus fractional Er: YAG laser in facial rejuvenation. *J Cosmet Dermatol* 2020;**19**(6):1333-40. doi: 10.1111/jocd.13440.
  25. Serdar ZA, Tatlıparmak A. Comparison of efficacy and safety of fractional radiofrequency and fractional Er: YAG laser in facial and neck wrinkles: Six-year experience with 333 patients. *Dermatol Ther* 2019;**32**(5):e13054. doi: 10.1111/dth.13054.