

Evaluation of the effectiveness of radio frequency (RF) treatment on improving the overall appearance of the facial skin in women – a pilot study

Ocena skuteczności zabiegu radiofrekwencji RF na poprawę ogólną wyglądu skóry twarzy u kobiet – badania pilotażowe

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B – zestawienie danych

C – przeprowadzenie analizy statystycznej

D – interpretacja wyników

E – przygotowanie manuskryptu

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Abstract

Introduction: Aging facial skin is a natural and unavoidable process. It involves a gradual weakening of the biological activity of cells, extension of regenerative processes and reduction of adaptability. At the same time, a smooth, radiant, wrinkle-free complexion has been a global trend in cosmetology for many years, which results in more and more people, especially women, benefiting from new non-invasive anti-aging treatments. One of such treatments offered on the cosmetology market are treatments utilising RF radio waves. Therefore, the aim of this study was to assess the impact of a series of treatments utilising RF on the skin of the faces of women.

Materials and methods: The analysis of the results was carried out by the examined person and by the authors of the project via a point scale of visual assessment of skin condition. The following facial skin parameters were analysed in the study: depth of wrinkles, elasticity, skin brightening and moisturising.

Results and conclusions: The conducted own study proves the impact of treatments using RF radio waves on the skin of the face. The applied series of treatments caused a partial reduction of the most visible and deepest wrinkles, as well as improved elasticity, brightening and moisturising of the facial skin.

Keywords: skin aging, fibroblasts, fibroblasts, radio frequency (RF)

Introduction

Skin aging is a natural process consisting in reducing the biological activity of body cells, slowing down regenerative processes and loss of the body's adaptability [1]. Human skin ages throughout our lives and affects everyone. This process is associated with a slow and natural process of changes in the composition and arrangement of individual elements of connective tissue that builds all layers of the skin. The main cells of the dermis, fibroblasts, become less active and partially disappear. Capillaries atrophy occurs, there is a decrease in the number of collagen and

elastin fibers and proteoglycans. All these processes make the aging skin paler, thinner and less elastic, and wrinkles appear on its surface. This, in turn, leads to a reduction in the resistance of the skin to environmental factors, which means that the skin also becomes inadequately hydrated and less firm [2].

So far, we do not have scientific knowledge that would allow us to stop the skin aging process, we can only try to slow it down. At the same time, a smooth, radiant, wrinkle-free complexion has been a global trend in the scope of "beauty matters" for many years. Thus, the demand for specialist targeted treatments increases. That is why more and more people, especially women, benefit from new treatments offered by the aesthetic medicine and cosmetology market.

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When it comes to modern aesthetic medicine, it is a field that offers a wide range of mainly invasive procedures performed by plastic surgeons and aesthetic medicine doctors. These treatments effectively improve the appearance of the skin and rejuvenation effect [3]. Compared to treatments in aesthetic medicine, the effects of which are visible almost immediately, cosmetic treatments require a bit more time as well as regularity to achieve the desired rejuvenation of the facial skin. At present anti-aging cosmetology is based on the use of various types of i) active substances (e.g. retinoids, ceramides, isoflavones), ii) lifting massage techniques, and iii) cosmetic apparatus emitting various types of physical stimuli (e.g. ultrasound, electromagnetic waves, infrared radiation) without using invasive techniques in the field of aesthetic medicine [4, 5]. Especially the last two items are of great importance in modern anti-aging cosmetology. This is related to the issue of unregulated cases regarding the admissibility of invasive treatments by cosmetologists, involving the introduction of various types of substances/materials into tissues.

The latest achievements in the field of physiotherapy and cosmetology make the offered treatments more and more effective and often allow to obtain effects that were once only achievable with the help of aesthetic medicine [6]. Currently, rejuvenating electrotherapy treatments that use radio frequency electromagnetic fields, referred to in cosmetology as RF (*radio frequency*) radio waves have become very popular. In cosmetology, an electromagnetic frequency is used in the range of 1–7 MHz [7, 8]. During the interaction of radio waves in the dermis and subcutaneous tissue, heat is generated, which is the result of the movement of charged particles (ions) under the influence of an alternating electric field [8]. According to Augustyniak and Tazbir, the depth of penetration of radio waves into the skin is inversely proportional to the frequency of waves, so it is the smallest at the highest frequencies [4]. A relationship has also been found, namely: the more hydrated the skin and the more electrolytes it contains, the more heat it generates [9]. Collagen fibers become shortened in RF-treated skin due to the breakage of some intermolecular cross-links [10]. This leads to the development of the collagen triple helix, shortening and thickening of its fibers, which consequently affects the appearance of the skin lifting effect after the treatment. Partial denaturation of collagen fibers also initiates the repair process leading to skin remodeling, which is characteristic of wound healing after injury [11, 12]. During this complex process, on the one hand, the damaged collagen is digested by proteolytic enzymes called metalloproteinases, and on the other, fibroblasts are stimulated with collagen breakdown products to synthesize its new molecules [11, 13]. During review of the literature it also became known that in order to improve skin firmness and elasticity, it is enough to collapse and thicken the collagen arrangement while maintaining intermolecular cross-links [4].

Radio waves also cause physiological effects and reactions associated with the body's thermoregulatory response by heating the dermis and subcutaneous tissue. Increased skin temperature results in the expansion of blood vessels, increasing the level of transport of oxygen and nutrients to tissues, and also causes faster disposal of unnecessary waste products [14, 15].

Currently, numerous experiments on radio waves are conducted, but the vast majority of these studies are basic, they consider the effect of RF on cellular mechanisms in connective tissue [16]. However, there are still few clinical studies with good quality methodologies regarding the effectiveness and actual role of RF in eliminating the symptoms of skin aging.

Therefore, the aim of this study was to assess the impact of a series of treatments utilising RF on the skin of the faces of women. The analysis of the results was carried out by the examined person and by the authors of the project via a point scale of visual assessment of skin condition. The following facial skin parameters were analysed in the study: depth of wrinkles, elasticity, skin brightening and moisturising.

Materials and methods

30 patients volunteered to participate in the research project. However, only 8 of them met the eligibility criteria and such a group took part in the pilot study. The examined women were between 45 and 50 years old, had a BMI index normal, had mimic wrinkles (lion's wrinkle, nasolabial folds and crow's feet), while they did not have acne lesions or signs of rosacea.

Exclusion criteria

- pregnancy and breast feeding period,
- acute inflammation of veins and lymph vessels,
- neoplastic diseases up to 5 years,
- venous thrombosis,
- presence of metal implants in the treated area,
- acute local and general inflammation,
- post-traumatic conditions with edema
- coronary and peripheral circulatory disorders,
- tuberculosis,
- pacemaker [17].

The women participating in the study had to drink a minimum of one and a half liters of water a day, avoid the use of foundations when applying make-up and use only moisturising cream. All examined people signed an informed consent to participate in the research project and in a series of treatments carried out.

The questionnaire contained 12 questions, including seven open and five closed questions. The questions concerned: age, lifestyle, past diseases, allergies, medications taken and cosmetic procedures carried out previously. The questions also concerned the cosmetics used for skin care and attendance at a solarium.

The purpose of the survey form was also to obtain information on selected facial skin features of the surveyed women. After a series of treatments, the degree of wrinkle reduction, skin elasticity, skin brightening and facial skin hydration were assessed. All these features were assessed by the same cosmetologist (the author of the project), based on the five-point scale described in Table 1.

treatments, an apparatus was used that emits BIONIC RF electromagnetic waves and has the following parameters, voltage: 220/110V, frequency: 50/60Hz, power: 110 mW, energy: 8 levels. As for the device itself used for the treatments, it has heads: a Bi-polar RF head – producing deep heat, penetrating the skin up to 5–15 mm.

An Infinity video recorder (skin and hair analyser) was also

Table 1. Criteria for assessing selected skin parameters

Assessment criteria				
Scoring	Depth of wrinkles	Skin elasticity	Skin brightening	Skin hydration
0	no wrinkles	elastic	lightened	hydrated
1	barely visible wrinkles	visibly elastic	barely visible brightening	barely visible hydration
2	moderately visible wrinkles	moderately elastic	moderately visible illumination	moderately visible hydration
3	visible wrinkles	visible lack of elasticity	visible lack of brightening	visible lack of hydration
4	very visible wrinkles	very visible lack of elasticity	very visible lack of brightening	very visible lack of hydration

In addition, the survey form included a table in which the examined women assessed their feelings in relation to the effects of the procedure, estimating them via a 4-point scale, where 1 meant “very satisfactory”, 2 – “moderately satisfactory”, 3 – “hardly satisfactory”, and 4 “no effects”.

used during the study. This device allows for a very high magnification of the examined area of the skin. The video recorder is connected to a laptop displaying the image of the examined area (Table 2).

Table 2. Comparison of wrinkle depth among the examined women before and after a series of RF treatments

		Feature examined: Wrinkles n %				
		0	1	2	3	4
Before treatments	0 0%	1 12.5%	2 25%	3 37.5%	2 25%	
After treatments	0 0%	2 25%	2 25%	3 37.5%	1 12.5%	

a) **Photographic documentation** – in order to further illustrate the effects of the therapy used, before and after a series of treatments, each patient’s entire face has been photographed (digital camera, Canon) and dermatoscope (Infinity video recorder).

b) **Methodology of performing the treatments** – for each examined woman a series of 5 treatments was performed at intervals of 7 days. Each treatment lasted 20 min, the first and second were on the 3rd degree of wave intensity, the third and fourth on the 4th degree, and the fifth on the 5th of intensity scale. During the project none of the women changed the way of their home skin care. Treatments were carried out in a beauty salon, while fully respecting hygiene standards. To perform the

Results

After the series of treatments used, the number of very visible, deep wrinkles decreased, marked according to the rating scale as 4, while the number of women with barely visible wrinkles marked according to the rating scale as 1 decreased (Table 2).

In the case of the skin elasticity parameter, after a series of treatments, there was no “very visible lack of elasticity” observed among the examined women, and before the examination this problem had been identified among 25% of the examined (Table 3).

In the case of the “skin brightening” parameter, 25% of women had an increase in skin brightness after a series of treatments,

while it had not been noticed among any of the women before the examination (Table 4).

Most women, that is 50%, indicated “moderate satisfaction” with the results of the treatments used, 37.5% of women were

Table 3. Comparison of skin elasticity among the examined women before and after a series of RF treatments

		Feature examined: Elasticity of the skin n %				
		0	1	2	3	4
Before treatments		0 0%	2 25%	1 12.5%	3 37.5%	2 25%
After treatments		0 0%	4 50%	3 37.5%	1 12.5%	0 0%

Table 4. Comparison of skin brightening among the examined women before and after a series of RF treatments

		Feature examined: Brightening of the skin n %				
		0	1	2	3	4
Before treatments		0 0%	2 25%	4 50%	2 25%	0 0%
After treatments		2 25%	4 50%	2 25%	0 0%	0 0%

In the case of skin hydration, these treatments resulted in 12.5% improvement among the examined women who had “very noticeable lack of hydration” or “visible lack of hydration” prior to treatments. An improvement in skin hydration was also observed among 25% of women who were diagnosed with “moderately visible hydration” before treatments (Table 5).

In addition, after completing the project, each of the examined women had the opportunity to assess the effectiveness of the performed procedures based on their own feelings (Table 6).

“very satisfied”, while 12.5% of women were “hardly satisfied” with achieved post-treatment effects.

A photographic documentation of part of the face and close-up of a fragment of skin was made twice in the case of each woman participating in the project.

Below are sample photos taken of one of the examined women.

Table 5. Comparison of skin hydration among the examined women before and after a series of RF treatments

		Feature examined: Hydration of the skin n %				
		0	1	2	3	4
Before treatments		0 0%	1 12.5%	2 25%	4 50%	1 12.5%
After treatments		0 0%	1 12.5%	4 50%	3 37.5%	0 0%

Table 6. Individual feelings regarding effects among the examined people after a series of RF treatments

Very satisfactory		Moderately satisfactory		Hardly satisfactory		No effects	
n	%	n	%	n	%	n	%
3	37.5	4	50	1	12.5	0	0



Figure 1. Video recorder examination before treatments

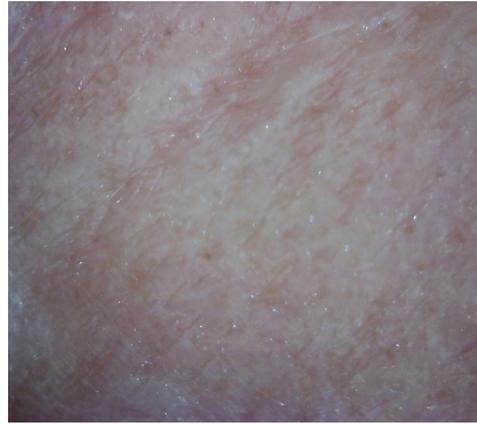


Figure 2. Video recorder examination after treatments



Figure 3. Forehead before treatments



Figure 4. Forehead after a series of treatments

Discussion

For years, scientists have been looking for the causes responsible for the aging of the body, including facial skin. The lesions that occur at the earliest in the aging process of the face are wrinkles, especially around the eyes, the so-called “crow’s feet”. The more the aging process progresses, the easier it is to notice changes in the shape of the oval of the face, which gradually falls due to gravity [18]. Both external and internal factors of the body contribute to the appearance of wrinkles. One of the internal factors playing a large role in the skin aging process is the disappearance or decrease of activity of fibroblasts, i.e. the cells responsible for the production of extracellular matrix (*ECM*), including collagen and elastic fibers [11, 19]. Data from the literature indicate that the use of radio waves helps stimulate fibroblasts to produce and remodel connective tissue fibers, which may contribute to wrinkle reduction [11, 20]. It is also known that the heat generated in the skin under the influence of radio frequency leads to the production of heat shock proteins (*HSP*), which stimulate T lymphocytes and monocytes to produce cytokines and fibroblast growth factor-2 (*FGF-2*). In turn, these factors stimulate fibroblasts to increase the production of extracellular matrix components [21]. The results of the author’s examinations have shown the impact of a series of radio frequency treatments on wrinkle reduction. The best results were achieved among women who had very visible and deep wrinkles. Confirmation of the results of these examinations are

photos of the skin taken with the video recorder before and after a series of treatments, which show a significant improvement in the appearance of the skin consisting in shallowing of transverse forehead wrinkles (Fig. 1–4).

The skin with signs of aging becomes thin and not firm. This is the result of structural disorders within the cross-linking of skin connective tissue fibers that are responsible for its elasticity. An attempt to make the facial skin more flexible is another area of application of radio waves [22, 23, 24]. The effects of this therapy cannot be compared with the effects of aesthetic medicine, but they are a good alternative for people who want a painless, non-invasive way to improve the elasticity of their skin. In this study, both the examined person and the persons conducting the examination noted the improvement of skin elasticity after a series of RF treatments. In this case, studies by other scientists also confirm the effectiveness of using radio frequency to make facial skin more flexible [25, 26].

The skin aging process is also associated with the problem of excessive dryness of the skin due to reduced water accumulation capacity. This, in turn, translates into insufficient hydration and, consequently, also its matte appearance (no brightening of the skin). It appears that due to the RF treatment, which increases the heat of the skin, capillary blood vessels expand and, as a consequence, oxygen and nutrients are transported at an accelerated rate. These actions result in better nutrition and oxygenation of the skin, which in turn manifests itself in better brightening and hydration of the skin [25, 26]. This concept is confirmed by the

author's examinations because, as a result of the use of RF in the examined women, an improvement in skin brightening and hydration was observed.

Conclusions

1. The applied series of RF treatments caused a partial reduction of the most visible and deepest wrinkles, as well as improved elasticity, brightening and moisturising of the facial skin among the examined women.
2. The conducted treatments were positively evaluated by the examined women.

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Streszczenie

Wprowadzenie: Starzenie się skóry twarzy jest procesem naturalnym i nieuniknionym. Polega on na stopniowym słabnięciu aktywności biologicznej komórek, wydłużaniu procesów regeneracyjnych oraz obniżaniu zdolności adaptacyjnych. Jednocześnie światowym trendem w kosmetologii od wielu lat pozostaje gładka, promienista, pozbawiona zmarszczek cera co powoduje, że coraz więcej osób, a zwłaszcza kobiet, korzysta z nowych nieinwazyjnych zabiegów przeciwstarzeniowych. Jednym z takich zabiegów oferowanych na rynku kosmetycznym są zabiegi z użyciem fal radiowych RF. Dlatego też celem niniejszej pracy była ocena wpływu serii zabiegów przy użyciu RF na skórę twarzy kobiet.

Material i metody: Analizę wyników przeprowadzono za pomocą skali punktowej wizualnej oceny stanu skóry przez osobę badaną oraz przez autorki projektu. W badaniach analizowano następujące parametry skóry twarzy: głębokość zmarszczek, elastyczność, rozświetlenie i nawilżenie skóry.

Wyniki i wnioski: Przeprowadzone badania własne dowodzą wpływu zabiegów z zastosowaniem fal radiowych RF na skórę twarzy. Zastosowana seria zabiegów spowodowała częściową redukcję najbardziej widocznych i najgłębszych zmarszczek, a także poprawę elastyczności, rozświetlenia i nawilżenia skóry twarzy.

Słowa kluczowe: starzenie się skóry, fibroblasty, fibroblasty, radiofrekwencja RF
