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Combined treatment of atrophic scars using radiofrequency microneedling and hyaluronic acid fillers with subcision

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Abstract

Introduction. Atrophic scars may be associated with significant psychological stress and a substantial negative impact on quality of life. Despite the great relevance of the atrophic scars therapy, existing treatment methods do not always provide their complete elimination.

Aim. To study the efficacy of combined therapy of atrophic scars with radiofrequency microneedling (RF-MN), subcision and hyaluronic acid filler injection.

Materials and methods. Ten female patients aged 28–44 years with a clinical diagnosis of atrophic scars were randomly assigned to one of two groups. Group 1 received RF-MN alone, while Group 2 received a combination treatment comprising RF-MN, subcision, and hyaluronic acid injections. Clinical effectiveness was assessed using the Goodman-Baron scar rating scale and the Global Aesthetic Improvement Scale (GAIS). Ultrasound was used to determine the changes in dermal thickness. The volume of depressions and skin texture were measured using the Antera 3D®. The safety of the treatment was evaluated by recording adverse events.

Results. The combined method demonstrated superior efficacy compared to RF-MN alone in the majority of efficacy parameters. In Group 2, a statistically significant reduction in Goodman-Baron scale was observed in 100% of patients ($p = 0.026$). 3D measurements of the face demonstrated a more pronounced improvement in skin texture in Group 2 relative to Group 1. Statistically significant changes ($p = 0.027$) in the Face-Q scale were exclusively observed in the group that received the combined treatment. Ultrasonic imaging demonstrated a restoration of dermal thickness following treatment. No serious adverse events were observed. Expected local adverse events (pain, erythema, swelling and bruising) were mild and resolved spontaneously within 1–7 days.

Conclusion. The combined treatment with RF-MN followed by subcision and hyaluronic acid filler injections demonstrated its efficacy in patients with atrophic scars.

Keywords: atrophic scars, radiofrequency microneedling, subcision, hyaluronic acid, dermal fillers, combination treatment, ultrasound, 3D measurement

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Комбинированная терапия атрофических рубцов радиоволновым методом воздействия и филлерами на основе гиалуроновой кислоты с предварительной субцизией

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Резюме

Введение. Атрофические рубцы могут являться причиной психоэмоциональных расстройств и снижения качества жизни пациентов. Несмотря на большую актуальность вопроса коррекции атрофических рубцов, существующие методы лечения не всегда обеспечивают их полное устранение.

Цель. Оценить эффективность и безопасность комбинированной терапии атрофических рубцов с применением игольчатого радиоволнового метода воздействия (RF), субцизии и филлеров на основе гиалуроновой кислоты.

Материалы и методы. Включенные в исследование 10 пациенток в возрасте 28–44 лет с клиническим диагнозом атрофических рубцов рандомизировали в 2 группы с проведением RF в виде монотерапии (группа 1) и применением комбинации RF, субцизии и введением филлера на основе гиалуроновой кислоты (группа 2). Клиническую эффективность оценивали с помощью шкалы выраженности рубцов Goodman и Baron и шкалы общего эстетического улучшения (GAIS). Для определения динамики изменения толщины дермы выполнялось ультразвуковое исследование. Измерение объема углублений и текстуры кожи (3D-диагностика кожи лица) осуществляли с помощью аппарата Antera 3D®. Оценку безопасности процедур выполняли путем регистрации нежелательных явлений.

Результаты. По большинству показателей эффективности комбинированный метод обладал преимуществом по сравнению монотерапией. В группе 2 статистически значимое снижение выраженности рубцов по шкале Goodman и Baron было отмечено у 100% пациентов (p = 0,026). 3D-диагностика кожи лица показала в группе 2 более выраженное улучшение текстуры кожи по сравнению с группой 1. Значимая динамика (p = 0,027) в изменении показателей по шкале Face-Q наблюдалась только в группе, получавшей комбинированное лечение. Ультразвуковая картина в динамике подтверждала восстановление толщины дермы на фоне лечения. Серьезных нежелательных явлений зарегистрировано не было. Ожидаемые местные нежелательные явления (болезненность, эритема, отек и кровоизлияния) были выражены в незначительной или легкой степени и самопроизвольно разрешались в течение 1–7 дней.

Заключение. Представленный метод, основанный на проведении курса процедур RF с последующей субцизией и введением гиалуроновой кислоты, подтвердил свою эффективность у пациентов с атрофическими рубцами.

Ключевые слова: атрофические рубцы, игольчатый радиоволновой метод воздействия, субцизия, гиалуроновая кислота, дермальные филлеры, комбинированное применение, ультразвуковое исследование, 3D-диагностика

Для цитирования: Акопян ИХ, Мураков СВ, Грачева СГ, Бондаренко ИН, Тимофеев АВ, Васильев СВ. Комбинированная терапия атрофических рубцов радиоволновым методом воздействия и филлерами на основе гиалуроновой кислоты с предварительной субцизией. *Медицинский совет*. 2024;18(14):164–176. https://doi.org/10.21518/ms2024-358.

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INTRODUCTION

Scars are connective tissue areas resulting from chemical, mechanical, or thermal injury, surgical wounds, invasive procedures, and various diseases [1, 2]. The clinical and morphologic type of scars primarily depends on excessive or deficient production of structural extracellular matrix proteins such as collagen and elastin. Atrophic scars are characterized by a decreased number of collagen and elastic fibers and their thinning due to impaired physiological regeneration affected by various systemic and local factors [3]. An immunohistochemical study showed that the formation of atrophic scar tissue is associated with interdependent mechanisms, namely, degradation of collagen and elastic fibers by matrix metalloproteinases with decreased levels of their tissue inhibitors, and increased production of proinflammatory cytokines and transcriptional nuclear factor kappa B (NF-κB), which mediate inhibition of cell proliferation and destruction of the extracellular matrix [4–6]. This histologic pattern defines the main clinical feature of atrophic scars: they are located below the healthy skin level.

Atrophic scars are not a health hazard, but when they develop on the face and exposed areas of the body, they can cause psychological and emotional problems and decrease the quality of life and self-esteem in patients. In addition, a morphology study [7] showed that atrophic scars account for 42.8% of all facial scars; 61.3% of post-acne scars, 88.0% of other scars resulting from dermatologic conditions, 28.1% of surgical scars, and 47.9% of traumatic scars are atrophic.

Despite the importance of treating atrophic scars and a deep understanding of their pathogenesis, there are no standardized treatment regimens that would be backed by convincing evidence and ensure complete scar resolution [8]. However, treatment options used in dermatology and cosmetology induce neocollagenesis, re-epithelialization, and remodeling of dermal structures, thus reducing scar depth, improving skin landscape, with quite satisfactory aesthetic outcomes.

The choice of the optimal treatment option depends not only on the type of scar, but also on its location, clinical characteristics, and severity of changes [9–11].

Subcision is considered one of the most effective methods of treating atrophic scars, especially deep ones [12]. It involves inserting a needle under the scar defect and cutting the fibrous bands that tether the bottom of the scar to the underlying dermis. Controlled injury

with subcision activates wound healing, the formation of new collagen fibers, and other components of the extracellular matrix, so the scar floor is raised to the level of healthy skin. The use of dermal fillers, including those based on hyaluronic acid (HA), is recommended to restore the volume of the soft tissues under an atrophic scar after separation of fibrous bands, to visually smooth skin, and to promote the proliferation of fibroblasts secreting collagen and non-collagen proteins [13–18].

A study by Kapuler OM et al. demonstrated a favorable biocompatibility profile of HA fillers [19]; the use of MiraLine fillers (Feel Korea Co., South Korea) was not associated with adjacent tissue inflammation. An ultrasound (US) examination performed 3–4 weeks after the treatment confirmed the absence of fibrosis, the physiological integration of the gel into the surrounding tissues, and the persistence of the augmentation effect achieved during the treatment. MiraLine fillers are based on high-molecular-weight HA of non-animal origin obtained by bacterial fermentation. Despite the minimal use of a crosslinking agent, HA in MiraLine fillers has stable rheological properties which determine the predictable esthetic outcomes. Complete biodegradation of MiraLine fillers by hyaluronidase occurs within 2–5 minutes (depending on bolus volume) after administration, which confirms the safety of the esthetic treatment [19].

Highly effective energy-based techniques play a special role in the treatment of atrophic scars. Radiofrequency (RF) needling combines the benefits of microneedling and radiofrequency technology to target the deeper skin layers. Activation of dermal remodeling processes for new collagen and elastic fibers to form is achieved by the thermal effect of RF current on the dermis [9, 20]. Microneedles are used as electrodes that deliver an RF pulse directly into the dermal tissue to selectively heat the skin at a controlled depth of 0.5–3.5 mm. Due to the insulated surface of each needle, the thermal effect is limited to the area at the needle point, reducing the risk of side effects and promoting rapid recovery of the skin barrier function [20, 21].

Many studies demonstrated superiority of combination treatment compared to monotherapy [11, 20, 22, 23]. This paper presents the results of the combination treatment of atrophic scars with RF radiation followed by subcision and injection of HA fillers. This combination approach is very promising, as evidenced by the high efficacy rates of each of these methods alone.

High-resolution ultrasound is widely used for visualization of skin layers and dynamic monitoring of treatment outcomes, and is characterized by high rates of accuracy, reproducibility, and reliability of results [24, 25]. This non-invasive and patient-safe method determines the thickness of the dermal layers, the depth of the scar, its stiffness, and the vascularization characteristics in real time [26]. In a study found in the literature, ultrasound was used to demonstrate differences in dermal thickness in different areas of the face in young and middle-aged women [27]. These aspects should be considered when choosing the depth of energy exposure and injecting fillers. Ultrasound is a reliable method to qualitatively assess the condition of skin structures, personalize the treatment protocol, reduce the risk of adverse events (AEs), and monitor treatment outcomes over time.

The **aim** of this study is to evaluate the efficacy and safety of the combination treatment of atrophic scars using RF, subcision, and HA fillers.

MATERIALS AND METHODS

A prospective, open-label, randomized study of the efficacy of combination treatment of atrophic scars using RF, subcision, and HA filler injection was conducted at the Department of Dermatovenereology and Cosmetology of the Academy of Postgraduate Education under Federal Scientific and Clinical Center of Federal Medical-Biological Agency of Russia (Moscow) in 2024.

The study included 10 women aged 28–44 years with a clinical diagnosis of atrophic scars resulting from surgery (n = 1), resolution of inflammatory acne elements (n = 8), and varicella (n = 1). Study participation was voluntary. All patients who agreed to participate in the study signed an informed consent form prior to the study start. Exclusion criteria included contraindications for study treatment options; pregnancy and lactation; decompensated acute inflammatory, infectious, and chronic diseases; autoimmune diseases and cancer; HIV infection; viral hepatitis; tuberculosis; tendency to hypertrophic and keloid scar formation.

In addition, patients with non-biodegradable fillers or surgical implants in the treatment area were excluded.

Patients were randomized into two groups. Group 1 received three sessions of atrophic scar treatment using fractional RF with a tip equipped with 25 insulated gold-plated needles. The interval between treatment sessions was 3 weeks. In Group 2, three weeks after RF treatment, subcision was performed with a 21G injection needle at the same time intervals, followed by intradermal injection of MiraLine Fine filler based on stabilized HA (0.5–1.0 mL total). Topical anesthesia (cream containing 2.5% lidocaine and 2.5% prilocaine) was used prior to RF and subcision. Prior to the study procedures, a medical history was collected, and the appearance, texture, and depth of the scar tissue were visually assessed. Clinical efficacy was evaluated using the validated Goodman and Baron qualitative and quantitative scar assessment scale and the validated 5-point Global Aesthetic Improvement Scale (GAIS) as rated by a physician (PGAIS) and a subject (SGAIS), with a score of +3 corresponding to "significantly better" and a score of -3 corresponding to "significantly worse." In addition, at the end of treatment, patients were asked to rate their satisfaction with treatment outcome using the Face-Q scale from +3 for "very satisfied" to -3 for "very dissatisfied."

Ultrasound of the treatment area was performed with LOGIQ e® (GE HealthCare, USA) using an L8-18I-RS

linear high-frequency sensor in B-mode and color Doppler mapping mode at a scanning depth of 5–20 mm to determine the morphologic characteristics of atrophic scars, their dermal depth, and tissue thickness and vascularization before and after treatment. The echogenicity and echo structure of the dermis were determined, and the thickness of the intact skin and the skin in the projection of the scar was measured. To standardize the protocol, the study used the same mode settings on a gel pad (a thick layer of gel to minimize sensor pressure on soft tissue).

Linear dimensions, surface projection area of atrophic scars, depression volume, and micro-landscape of the affected area surface were measured using Antera 3D® (Miravex Limited, Ireland). After treatment, patients underwent a 3D facial skin examination using VISIA, followed by a physician assessment of treatment efficacy using the following scale: a score of 0–25% for poor treatment outcome with no to minimal improvement; 26–50% for satisfactory treatment outcome with mild to moderate improvement; 51–75% for satisfactory treatment outcome with significant improvement; and 76–100% for complete or almost complete resolution of all scars with high level of patient satisfaction.

Safety was evaluated by reporting adverse events (AEs) during the study period. A visual analog scale ranging from 0 (no pain) to 10 (unbearable pain) was used to rate the intensity of the post-treatment pain. The severity of erythema and edema was rated by patients using a 5-point scale.

In accordance with the protocol, this study used the generally accepted significance level of $\alpha = 5\%$ to assess two-sided confidence intervals and to test statistical hypotheses. The interval data were tested for normality using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Since the data distribution was non-normal, descriptive statistics were presented as median (Me) and interquartile range (IQR). Depending on the characteristic, the following nonparametric methods were used for hypothesis testing: the Mann–Whitney *U* test for comparing two independent quantitative or ordinal samples, the Wilcoxon test for comparing two related quantitative or ordinal samples; the χ^2 test for comparing multiple proportions, or the Fisher–Freeman–Halton test when the Pearson's χ^2 test was inappropriate (appropriateness was tested by the Simonov–Tsai test). Agreement between investigator and patient ratings was assessed using the Kendall's coefficient of concordance. STATISTICA and AtteStat were used for statistical calculations.

RESULTS

At baseline, 30% of patients had moderate scar lesions and 70% had severe scar lesions according to the Goodman and Baron quantitative scar scale. The main characteristics of the patient groups were comparable before the start of treatment (no statistically significant difference at $P > 0.05$).

Before treatment, no statistically significant differences were reported between the study groups in the thickness of the dermal layer in the projection of scars. After treatment, this parameter increased, with individual changes ranging from 1.1% to 12.7%. The change in the dermal layer thickness was statistically significant ($P = 0.028$) only in Group 2, which received the combination treatment (*Table 1*). The lack of significant changes in Group 1 may be explained in part by the small sample size.

At baseline, there were no statistically significant differences ($P = 0.500$) between groups in the severity of atrophic scars according to the Goodman and Baron scale (*Table 2*). It should be noted that Group 1 showed no change in scar severity after treatment; changes in scores were not statistically significant ($P > 0.999$). Meanwhile, 100% of patients in Group 2 showed a statistically significant decrease in scar severity according to the Goodman and Baron scale ($P = 0.026$) after the combination treatment.

Ultrasound showed heterogeneous skin structure in the study area with hyperechoic epidermis, hypoechoic papillary and hyperechoic reticular layer of dermis. The mean thickness was 1.67 mm, with the decreased parameter in the area of projection of atrophic scars compared to relatively unchanged areas (1.55 mm). The dermis in the projection of scars differed from adjacent areas and was characterized by lack of differentiation into papillary and reticular layers, based on increased or decreased echogenicity (*Figures 1A, 2A, 3A*). Color Doppler mapping revealed isolated vascular structures at the level of the hypodermis. During the treatment, the ultrasound pattern changed over time; in terms of echogenicity, the structures in the projection of the scars were virtually indistinguishable from areas of healthy skin; the dermal thickness of the dermis was restored (*Figures 1B, 2B, 3B*).

In the combination treatment group (RF + subcision + HA filler), a more significant improvement in skin texture was demonstrated for the depression volume and surface texture of the affected area using Antera 3D® compared to the RF monotherapy group (*Table 3*).

The lack of statistically significant differences in scar size (volume, width, and depth) between the groups can only be explained by the small sample size, as the median values show a clear benefit of the combination treatment.

3D imaging (VISIA) and physician assessment of the skin condition showed that the combination treatment was more effective, with most patients (75%) in Group 1 showing an improvement of 10% to 25%, 50% of patients in Group 2 showing an improvement of 26% to 50%, and the remaining 50% showing an improvement of 51% to 75% (*Table 4*). The difference between the groups for this parameter was statistically significant ($P = 0.033$).

The efficacy of both treatment regimens was confirmed by the Subject Global Aesthetic Improvement Score (SGAIS): 100% of patients in the monotherapy group reported improved skin condition, while most patients (83%) in the combination treatment group rated the treatment

Table 1. Post-treatment changes in dermal thickness at the area of atrophic scars
Таблица 1. Изменение толщины дермы в проекции рубцов в результате лечения

Group	Parameter	Before treatment (mm)	After treatment (mm)	Change in individual values (%)	P* (significance of changes
1 (n = 4)	Me	1,63	1,71	+5,5	0,068
	IQR	(1,58–1,66)	(1,68–1,74)	(+2,9...+9,1)	–
2 (n = 6)	Me	1,70	1,76	+2,6	0,028
	IQR	(1,67–1,77)	(1,74–1,78)	(+1,9...+3,4)	–

* P-value with the Wilcoxon test.

outcome as significant improvement (*Table 5*). The differences in SGAIS between the groups were statistically significant, with $P = 0.010$. The lack of significant differences in PGAIS between groups is most likely explained by the small sample size, as patient and physician assessments were concordant (the coefficient of concordance was not less than 0.5 in both groups).

At baseline, there was no statistically significant difference in the Face-Q scores between the two groups ($P = 0.190$). After treatment, the differences were significant with $P = 0.005$ (*Table 6*); in Group 1, 50% of patients were "somewhat satisfied" or "dissatisfied," whereas in Group 2, most patients (83%) were "very satisfied." The remaining 17% of patients in this group were "satisfied" with the outcome. Statistically significant changes ($P = 0.027$) in Face-Q scores were reported only in the combination treatment group.

No serious AEs were reported in the study.

Both treatment options were comparable in terms of procedural pain intensity and erythema, edema, and hemorrhage (non-significant, $P > 0.05$). The results of the assessment of pain intensity and the severity of post-treatment erythema, edema, and hemorrhage, are shown in *Table 7*. All expected AEs resolved spontaneously within 1–7 days.

Table 2. Comparison of reduction in scarring severity (Goodman and Baron scale) between the groups
Таблица 2. Сравнение групп по снижению степени выраженности рубцов (шкала Goodman и Baron)

Group	Scar assessment	Before treatment		After treatment		P* (significance of changes)
		n	%	n	%	
1 (n = 4)	Macular (1 point)	0	0	0	0	>0.999
	Mild (2 points)	0	0	0	0	
	Moderate (3 points)	2	50	2	50	
	Severe (4 points)	2	50	2	50	
	Median score per group	3.5		3.5		
2 (n = 6)	Macular (1 point)	0	0	0	0	0.026
	Mild (2 points)	0	0	1	17	
	Moderate (3 points)	1	17	5	83	
	Severe (4 points)	5	83	0	0	
	Median score per group	4.0		3.0		
p** (between-group comparison)		0.500		0.033		–

* P-value with the Wilcoxon test.
** P-value by with Freeman – Halton test

Therefore, the combination of RF, subcision, and HA filler was superior to monotherapy for most of the efficacy parameters evaluated in the study. In addition, both treatment options had similar safety profiles.

DISCUSSION

This study confirms the positive therapeutic effect of the combination treatment of atrophic scars of various origins with RF, subcision, and an HA filler and its superiority over RF as a monotherapy. The combined use of RF,

Figure 1. B-mode ultrasound scans of the temporal area before (A) and after (B) RF treatment: dermis (yellow arrows) and atrophic scar (blue arrows)
Рисунок 1. Эхограммы мягких тканей в проекции височной ямки в B-режиме до (A) и после (B) воздействия RF: дерма (желтые стрелки), проекция атрофического рубца (синие стрелки)

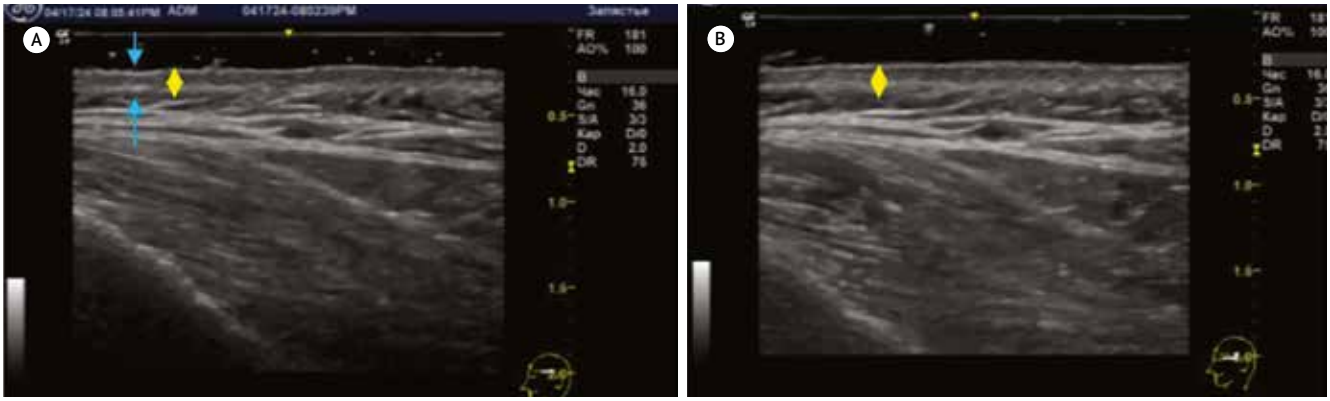


Figure 2. B-mode ultrasound scans of the temporal area before (A) and after (B) combined treatment: dermis (yellow arrows), hyperechoic dermis at the area of atrophic scar (blue arrows), and subdermal anechoic filler at the area of atrophic scar (red arrows)
Рисунок 2. Эхограммы мягких тканей в проекции височной ямки в В-режиме до (А) и после (В) комбинированного воздействия: дерма (желтые стрелки), участок повышения эхогенности дермы в проекции атрофического рубца (синие стрелки), анэхогенный филлер субдермально в проекции атрофического рубца (красные стрелки)

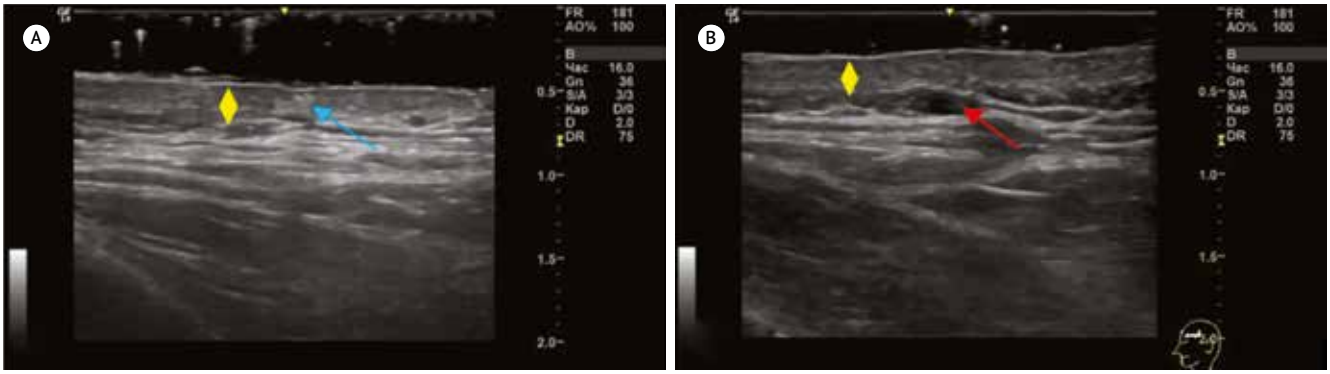


Figure 3. B-mode ultrasound scans of the temporal area before (A) and after (B) RF treatment: dermis (yellow arrows) and atrophic scar (blue arrows)
Рисунок 3. Эхограммы мягких тканей в проекции височной ямки в В-режиме до (А) и после (В) воздействия RF: дерма (желтые стрелки), проекция атрофического рубца (синие стрелки)

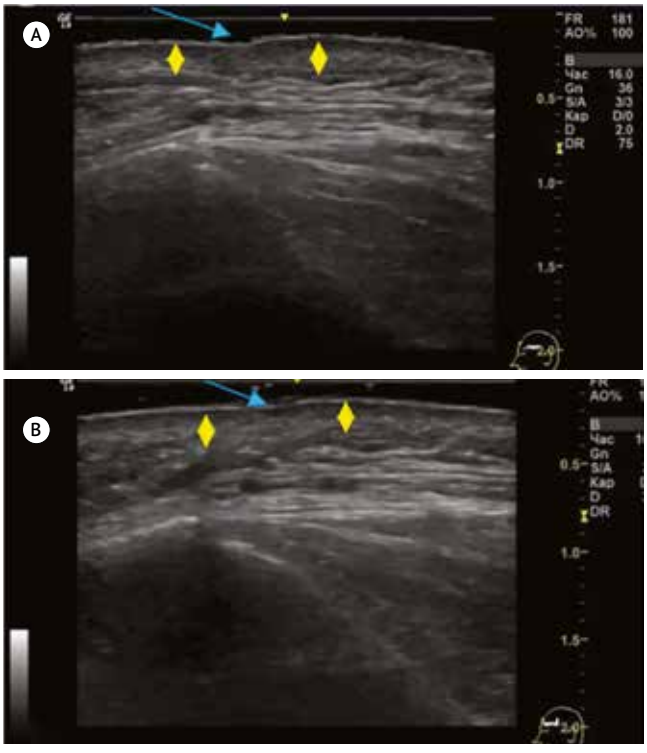


Table 3. Comparison of 3D parameters between the groups (Antera 3D®)
Таблица 3. Сравнение групп по 3D-визуализации рубцов (Antera 3D®)

Type of assessment (%)	Parameter	Group 1 (n = 4)	Group 2 (n = 6)	*P**
Improved skin texture	n	12	15	0.012
	Me	−8.86	−23.08	
	IQR	(−10.88, −5.47)	(−25.00, −18.21)	
Improved skin landscape	n	12	15	0.004
	Me	−5.56	−14.32	
	IQR	(−6.22, −2.43)	(−17.82, −11.51)	
Scar volume	n	3	12	0.066
	Me	−3.85	−37.26	
	IQR	(−11.60, −1.93)	(−100.00, −18.53)	
Scar width	n	3	18	0.206
	Me	−13.28	−31.16	
	IQR	(−19.48, −9.48)	(−95.29, −15.88)	
Scar depth	n	3	18	0.450
	Me	−10.87	−18.32	
	IQR	(−12.21, −6.14)	(−29.47, −4.20)	

* *P*-value with the Mann – Whitney U test.

subcision and an HA filler results in a greater decrease in atrophic scar severity on the Goodman and Baron scale than with RF alone.

The clinical improvement confirmed by the ultrasound data suggests that the combination of RF with subcision and intradermal use of a HA filler boosts the production of extracellular matrix components and stimulates the epidermal and dermal regeneration processes. Antera 3D® imaging showed that the combination of RF with subcision and stabilized HA injection contributed to a greater improvement in the skin texture in the area of atrophic scars (*Figures 4*, *5*) than RF alone (*Figures 6*, *7*).

The presented images of skin texture and scar width and depth confirm that the combination treatment is highly effective and significantly improves skin microlandscape and scar depression volume, while RF monotherapy is characterized by less prominent results.

Table 4. Comparison of 3D (VISIA) parameters between the groups
Таблица 4. Сравнение групп по шкале оценок 3D (VISIA)

Skin improvement (%)	Group 1 (n = 4)		Group 2 (n = 6)		*P**
	n	%	n	%	
10–25	3	75	0	0	0.033
26–50	1	25	3	50	
51–75	0	0	3	50	
76–100	0	0	0	0	

* *P*-value with the Freeman – Halton test.

Table 5. Comparison of GAIS scores between the groups
Таблица 5. Сравнение групп по шкале GAIS

Global Aesthetic Improvement Scale score	Group 1 (n = 4)		Group 2 (n = 6)		*P*
	n	%	n	%	
PGAIS					
Significantly better (3 points)	0	0	4	67	0.066
Better (2 points)	2	50	2	33	
No changes (1 point)	2	50	0	0	
Worse (-2 points)	0	0	0	0	
Significantly worse (-3 points)	0	0	0	0	
SGAIS					
Significantly better (3 points)	0	0	5	83	0.010
Better (2 points)	4	100	1	17	
No changes (1 point)	0	0	0	0	
Worse (-2 points)	0	0	0	0	
Significantly worse (-3 points)	0	0	0	0	
Agreement between physician and patient assessments (Kendall's coefficient of concordance)**	0.50		0.81		–

P-value with the Freeman – Halton test.
** *P*-value with the χ^2 test.

The data presented are largely consistent with previous efficacy studies. For example, a study of the HA efficacy in the treatment of atrophic scars of various origins showed a significant reduction in scar severity of more than 50%, with no serious and long-term adverse events [28, 29].

Hasson A and Romero WA showed that HA injection produced good or excellent results in 74% of patients with atrophic facial scars caused by acne, dog bites, basal cell carcinoma, and leishmaniasis [30]. Another study of facial atrophic scars showed a significant decrease

Table 6. Comparison of Face-Q scores between the groups
Таблица 6. Сравнение групп по шкале оценки удовлетворенности результатами лечения Face-Q

Group	Patient assessment	Before treatment		After treatment		*P** (significance of changes)
		n	%	n	%	
1 (n = 4)	Very satisfied	0	0	0	0	0.317
	Satisfied	0	0	0	0	
	Somewhat satisfied	1	25	2	50	
	Dissatisfied	3	75	2	50	
	Very dissatisfied	0	0	0	0	
2 (n = 6)	Very satisfied	0	0	5	83	0.027
	Satisfied	0	0	1	17	
	Somewhat satisfied	0	0	0	0	
	Dissatisfied	3	50	0	0	
	Very dissatisfied	3	50	0	0	
*P*** (between-group comparison)		0.190		0.005		–

P-value with the Wilcoxon test.
** *P*-value with the Freeman – Halton test.

Table 7. Comparison of procedural pain, post-treatment erythema and edema severities between the groups
Таблица 7. Сравнение групп по оценке болезненности, эритемы и отека в зонах коррекции

Assessment options	Group 1 (n = 4)		Group 2 (n = 6)		*P**
	n	%	n	%	
Pain intensity (using a 10-point VAS)					
No pain (score 0)	0	0	0	0	0.286
Score 1 of 10	0	0	0	0	
Score 2 of 10	0	0	1	16.7	
Score 3 of 10	2	50	4	66.7	
Score 4 of 10	2	50	1	16.7	
Erythema, edema, and hemorrhage					
None	0	0	0	0	0.119
Very mild	0	0	2	33	
Mild	2	50	4	67	
Moderate	2	50	0	0	
Severe erythema and edema	0	0	0	0	

* *P*-value with the Freeman – Halton test.

in the severity of atrophic scars 90 days after the last HA injection, and a significant decrease in the number of atrophic scars as assessed by the treating physician (-8.1 vs. -2.1; *P* = 0.00003) and by an independent investigator (-8.0 vs. -1.5; *P* = 0.00008) [31].

Despite the good methodological quality of data on efficacy of filler alone in the treatment of atrophic scars [8], their combined use with other options is becoming more widely accepted [32].

Several studies have confirmed the efficacy of fillers after subcision. For example, Ebrahim HM et al. proposed the combined use of subcision with intradermal HA fillers based on a comparison of clinical improvement rates in 40 patients with atrophic post-acne scars [33]. Treatment with fillers after subcision resulted in significant improvement in 94.1% of patients, while subcision alone was associated with less prominent results (67.3%). Dastgheib M et al. showed that two sessions of combined use of subcision and an HA filler with an interval of 1 month contributed to a more significant decrease in the severity of atrophic post-acne scars as rated by the patient than a single subcision session (*P* = 0.02) [34].

Other authors also reported a significant clinical improvement with the use of the study combination compared to subcision alone [35].

The combined use of RF and intradermal injections of HA fillers has been shown to be effective in esthetic medicine for facial rejuvenation and wrinkle

Figure 4. Skin texture at the right temporal area before (A, C) and after (B, D) the combined treatment of atrophic scars
Рисунок 4. Текстура кожи в области виска справа до (A, C) и после (B, D) лечения атрофических рубцов с применением комбинированного метода

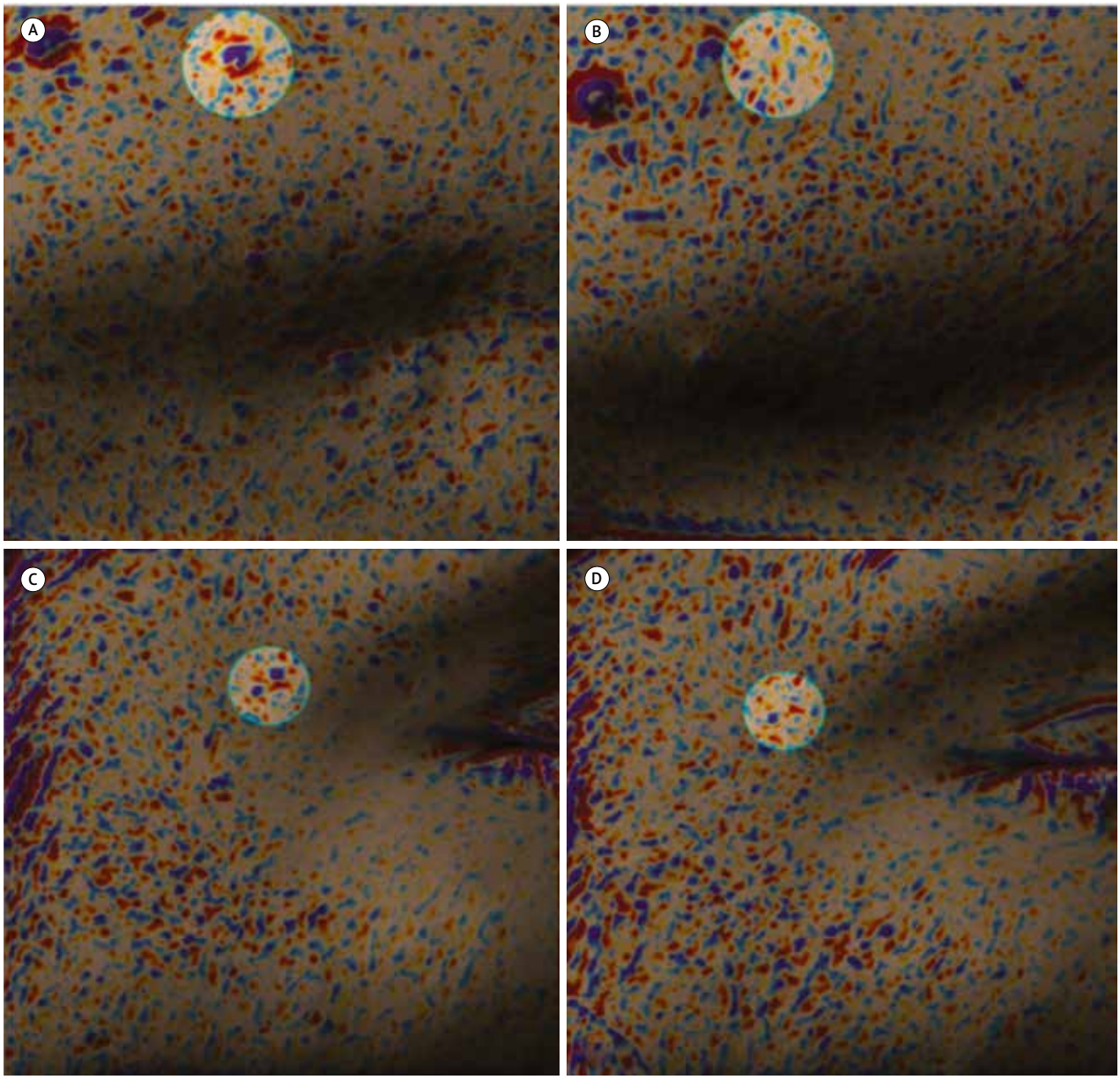
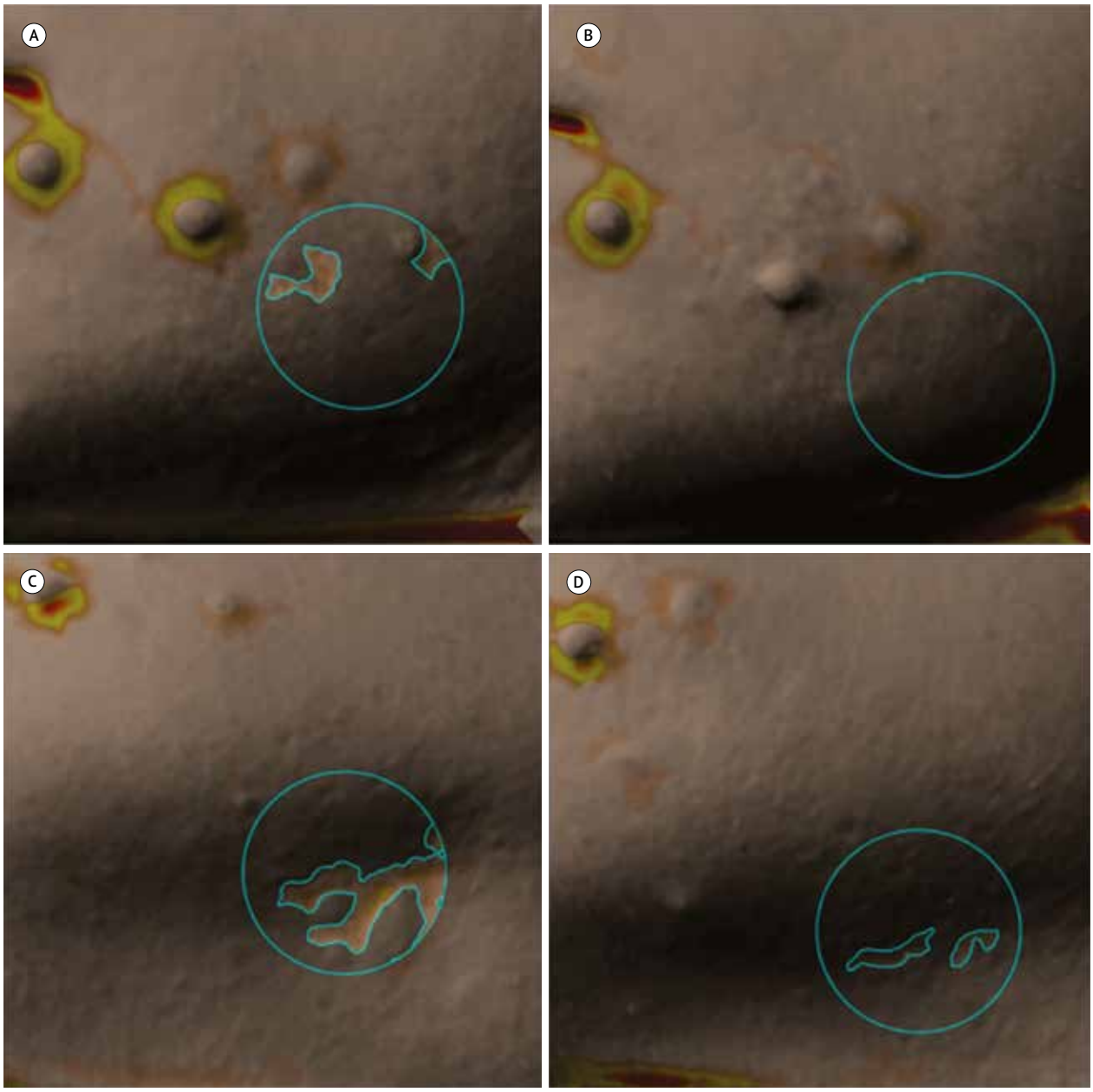


Figure 5. Volume of skin depressions before (A, C) and after (B, D) the combined treatment of atrophic scars
Рисунок 5. Объем углублений до (A, C) и после (B, D) лечения атрофических рубцов с применением комбинированного метода



correction [36–40]. However, there is limited literature on the use of RF in combination with HA to treat atrophic scars [41, 42], although numerous studies have confirmed the efficacy of these treatment options in patients with atrophic scars, both as monotherapy and in combination with other treatments [18, 43–46].

To illustrate, histology of tissue samples obtained after RF in patients with atrophic post-acne scars showed a significant formation of denser collagen fibers, the increased production of transforming growth factor beta 1 (TGF β), with decreased expression of the inflammatory mediators interleukin-8 (IL-8) and NF-κB, which was clinically associated with a significantly decreased scar severity and improved skin condition in 48–100% of patients [47–53].

For example, in 52 patients, 3 months after 4 sessions of fractional RF microneedling, the median severity of atrophic scars on the Goodman and Baron scale decreased from 16 ± 7.6 points to 5.6 ± 5.0 points ($P < 0.01$). In addition, 73.1% of patients achieved at least a 1-point decrease on the Goodman and Baron scale [49]. In another study, fractional RF microneedling was superior to bipolar RF in the treatment of atrophic acne scars, with statistically significant differences in the Investigator's Global Assessment (IGA) and Échelle d'Évaluation Clinique Des Cicatrices d'Acné (ECCA) response rates [47]. Kolcheva PS et al. confirmed that RF caused a more significant increase in epidermal and dermal thickness (by 36.69 and 16.22%, respectively; $P < 0.010$ and $P < 0.050$)

Figure 6. Skin texture at the left temporal area before (A) and after (B) treatment of atrophic scars with RF monotherapy
Рисунок 6. Текстура кожи в области виска слева до (A) и после (B) лечения атрофических рубцов RF-воздействием в виде монотерапии

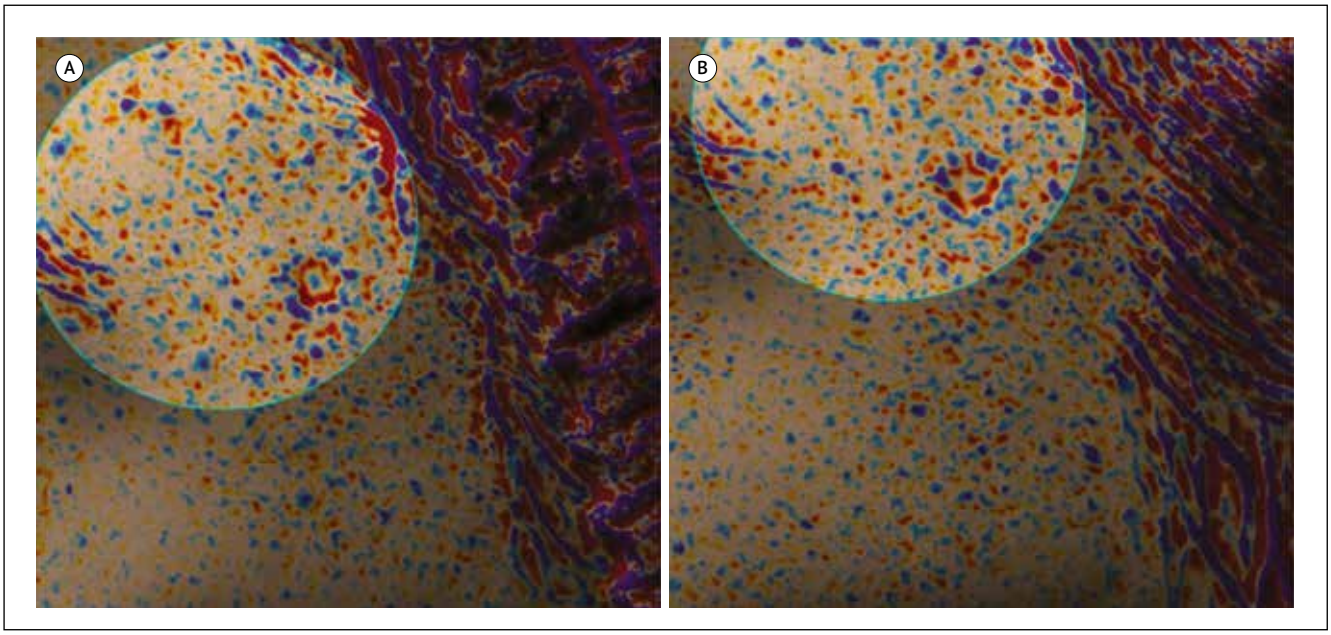
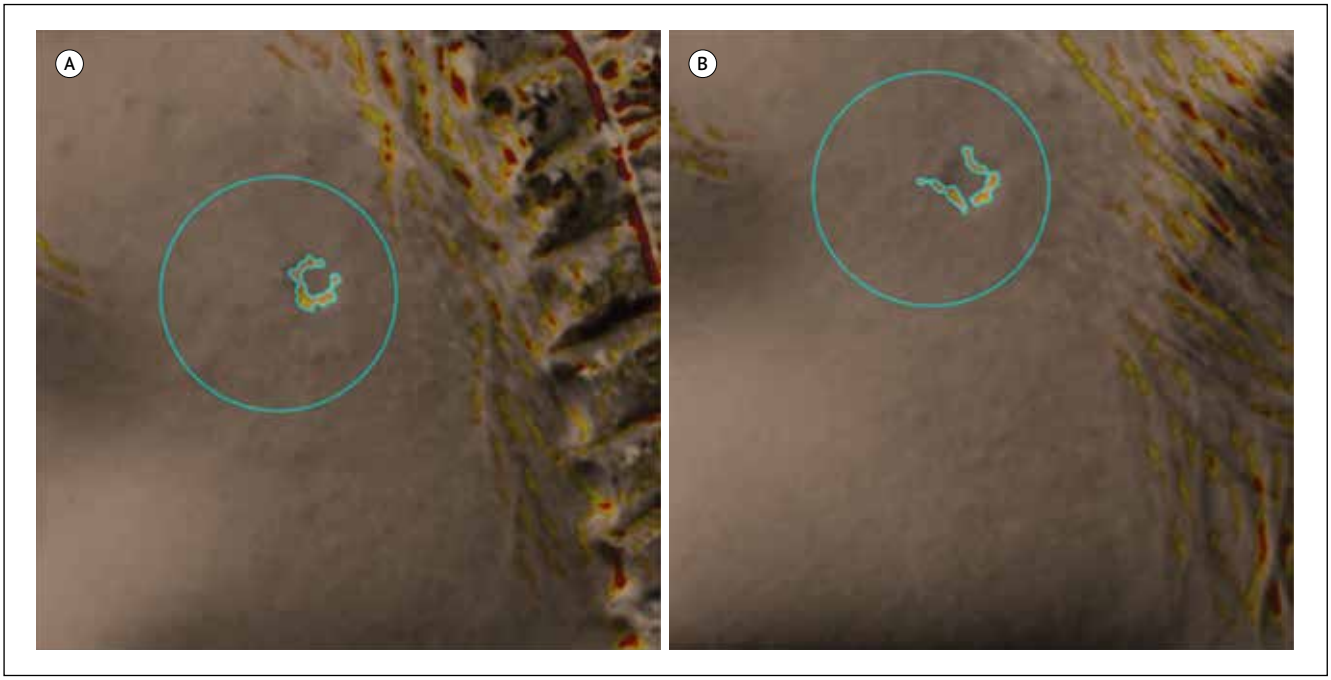


Figure 7. Volume of skin depressions at the left temporal area before (A) and after (B) treatment of atrophic scars with RF monotherapy
Рисунок 7. Объем углублений в области виска слева до (A) и после (B) лечения атрофических рубцов RF-воздействием в виде монотерапии



than Er:YAG laser (by 27.74 and 2.73%, respectively; $P < 0.010$ and $P < 0.050$). These results favored more significant positive changes after RF exposure [54]. In a study of age-related skin changes, immunohistochemistry showed that RF improved the quality of the dermal matrix and stimulated the synthesis of elastin and collagen [55].

Our ultrasound data showed increased dermal thickness and decreased echogenicity in the projection of scars after both RF monotherapy and the combined use of subcision and HA. We attributed these changes to the synthesis of dermal matrix proteins and glycosaminoglycans.

In the RF, subcision, and HA filler injection group, a more significant visual effect was achieved due to the separation of fibrous bands during subcision and the additional mechanical lifting of the scar floor by injection of an HA filler.

CONCLUSION

The proposed combination treatment for atrophic scars of various origins, based on RF followed by subcision and injection of an HA filler, has been shown to be effective in patients with scars of the specified morphologic type. The combination treatment was superior to monotherapy for the efficacy parameters evaluated. In particular, 100% of patients in the combination treatment group demonstrated a statistically significant decrease in atrophic scar severity and high patient satisfaction with the treatment outcomes. Ultrasound after the combination treatment showed the increased thickness of the dermal layer, and the measurement of linear dimensions, surface projection area, and volume of scar depressions confirmed a decrease in their volume, width and depth. The proposed treatment option has a favorable safety profile and provides acceptable esthetic results.

Further studies on the combined use of RF, subcision, and intradermal injection of HA fillers are warranted to confirm the efficacy and safety of the combination treatment and the possibility of its wider clinical use.

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