

Effect of Hexa-Polar Radiofrequency on Abdominal Skin Laxity Post Weight Reduction in Obese Adolescent Females

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Abstract:

Aim of the study: This study was conducted to determine the effect of hexa-polar radiofrequency on abdominal skin laxity post weight reduction in obese adolescent females. **Subjects:** Sixty overweight and obese adolescent females complaining of post weight reduction skin laxity participated in this study. They were selected randomly from Kasre El Ainy University Hospital in Cairo participated in this study. Their ages ranged from 17 to 21 years old. They were virgins. Their BMI were ranged from 25 to 35 kg/m². **Design:** The design of the study was a randomized controlled clinical trial. They were divided randomly into two equal groups; Group A (Control group): It was consisted of thirty adolescent females and were treated by tretinoin cream (Retin-A) on abdomen once every other day for 8 weeks. Group B (Study group): It was consisted of thirty adolescent females and were treated by tretinoin cream (Retin-A) on abdomen once every other day for 8 weeks in addition to hexa-polar radiofrequency for 30-40 minutes/session, 2 times/week for 8 weeks. **Assessment:** Pittsburgh rating scale was used to assess severity of abdominal skin laxity. Digital photography scale was used to assess percentage of improvement of skin laxity for all females in both groups (A&B) before and after treatment. **Results:** Results of this study found that; within groups; there was significant decrease in two point discrimination and Pittsburgh rating scale & significant increase in digital photography scale post treatment in both groups (A and B). Between groups; pretreatment; there was no significant difference between both groups (A and B) in two point discrimination, Pittsburgh rating scale and digital photography scale. While, post treatment; there was significant difference between both groups (A and B) in two point discrimination, Pittsburgh rating scale and digital photography scale (with favor of group B). **Conclusion:** So that, it could be concluded that hexa-polar radiofrequency is an effective method in reducing abdominal skin laxity post weight reduction in obese adolescent females.

Key words: Radiofrequency - Skin laxity - Obese - Adolescent females - Weight reduction.

INTRODUCTION:

Body skin laxity has emerged as an increasing aesthetic concern. Chronological aging, photoaging, and dimensional alterations during pregnancy or weight reduction can cause this laxity. Sagging, loose skin and concentrated adipose deposits represent the final outcome ¹.

Scientific research demonstrates that skin laxity and cellulite both correlate with reduced quantity and impaired function of dermal collagen fibers. Younger individuals frequently experience skin laxity following weight reduction or pregnancy, while older adults develop it due to decreased collagen synthesis and functionality. Lax skin histological examination reveals reduced collagen and elastin production and extracellular matrix abnormalities with elevated hyaluronic acid levels ².

Pediatric and adolescent obesity constitutes one of the 21st century's most demanding public health issues due to its worldwide epidemic proportions and related considerable morbidity, mortality, and public health expenditures ³.

Obesity represents a chronic condition featuring elevated body weight from abnormal or excessive adipose tissue accumulation ⁴. Lifestyle choices, cultural contexts, and environmental influences significantly contribute to high worldwide obesity prevalence. Typically, excessive consumption of high-carbohydrate and high-fat foods combined with inadequate physical activity causes overweight and obesity. However, evidence supports that excessive sugar consumption through soft drinks, enlarged portion sizes, and consistently declining physical activity have significantly contributed to global obesity rate increases, principally among adolescents ⁵.

Obesity treatment goals should redirect from weight reduction alone toward weight management, representing achievement of optimal weight within comprehensive health frameworks. Weight management encompasses adopting healthful and sustainable nutritional and exercise practices that reduce disease risk and improve energy and well-being sensations ⁶.

Weight loss program success has increased massive weight loss (MWL) patient numbers over recent years. Although weight reduction can improve obesity-related comorbidities including diabetes, hypertension, gastroesophageal reflux disease (GERD), sleep apnea, asthma, and depression, these patients frequently encounter new issues from redundant skin and tissue following weight loss ⁷.

The abdominal region represents the most frequent problematic area after MWL, even among mildly obese individuals. Redundant skin treatment represents a crucial and fundamental step for enhancing patient life quality ⁸.

Radiofrequency (RF) ranks among the most extensively utilized non-invasive procedures for addressing skin wrinkles and laxity. RF aims to stimulate collagen conformational changes and promote neocollagenesis through thermal energy generation in deep skin layers and subcutaneous tissues ⁹.

Radiofrequency energy devices have maintained dominance as the most prevalent technology in non-invasive skin tightening, wrinkle reduction, cellulite improvement, and body contouring enhancement management, treating all these conditions with relatively reliable outcomes ¹⁰.

Radiofrequency thermal stimulation creates microinflammatory fibroblast activation, producing new collagen (neocollagenesis), new elastin (neolastogenesis), and additional substances that enhance dermal architecture. RF has demonstrated effectiveness not only for skin tightening but also for adipocyte reduction ¹¹.

Radiofrequency functions primarily to promote tissue conformational modifications, inducing neocollagenesis through thermal generation in skin tissue deep layers, making it theoretically appropriate for wrinkle and skin laxity treatment

SUBJECTS, MATERIALS AND METHODS:

I- Subjects:

This study involved sixty overweight and obese adolescent females experiencing post-weight-reduction skin laxity. Researchers randomly selected participants from Kasre El Ainy University Hospital in Cairo. The study period extended from January 2024 through December 2024. Participants' ages spanned from 17 to 21 years. All female participants were virgins. Their BMI measurements ranged from 25 to 35 kg/m². The study excluded females with collagen diseases, skin integrity alterations including burns, wounds, keloids, hypertrophic scars, or dermatitis, and mental health conditions such as depression and anxiety.

Ethical consideration:

Researchers conducted this study following the Helsinki Declaration (World Medical Association Code of Ethics). The Faculty of Physical Therapy Ethical Committee at Cairo University, Egypt approved the study protocol (No:P.T.REC/012/003882). Female participants provided authorization through written consent forms with legal guardian acceptance before study procedures commenced.

Design of the study:

His study employed a randomized controlled clinical trial design (two group's pre-test, post-test design).

Randomization and blinding:

They were divided randomly by a random number generator was used to select numbers from sealed envelopes holding the study group's (30) and control group's (30) numbers, and females were assigned at random to each group. The participant-assigned sequences were put in envelopes with the group allocation inside. A random assignment was performed by an independent researcher who was not otherwise included in the experiment and was unaware of the research protocol. The group assignments were hidden from both the assessor and the participants. There were no participant withdrawals after randomization, as follow:

• Group A (Control group):

It was consisted of thirty adolescent females and were treated by tretinoin cream (Retin-A) on abdomen once every other day for 8 weeks ¹².

• Group B (Study group):

It was consisted of thirty adolescent females and were treated by tretinoin cream (Retin-A) on abdomen once every other day for 8 weeks in addition to hexa-polar radiofrequency for 30-40 minutes/ session, 2 times/week for 8 weeks.

II- Materials:

A- Assessment Materials:

- 1- Informed consent form.
- 2- Standard weight and height scale.
- 3- Tape measurement.
- 4- Skin laxity scale (The Pittsburgh Rating Scale).
- 5- Digital photography scale:

B- Treatment Materials:

1- Tretinoin cream (Retin-A cream):

It was used for treatment of skin laxity for all females in both groups (A & B).

2- Radiofrequency (Hexapolar):

Ultrasonic Cavitation with RF, Ultra-6550 device with output 66 V, frequency 3 MHz and power 35 W. It was used in treatment of all females in group B 2 sessions/ week for 8 weeks.

III- Procedures:

Researchers provided comprehensive explanations of evaluation and treatment procedures to all females, and each participant or guardian signed informed consent forms.

A- Evaluation procedures:

Researchers obtained detailed medical histories and conducted physical examinations for each female in both groups before study initiation.

1- BMI Assessment :

Researchers measured BMI for each female in both groups (A&B) before treatment to calculate BMI according to the equation:

$$\text{BMI} = \text{weight (Kg)} / \text{height (m}^2\text{)}^{13}$$

2- Two point discrimination:

The therapist used the tape measurement to measure the distance between:

- a) Distance 1 from Xiphoid process and the umbilicus
- b) Distance 2 Anterior superior iliac spine of right hip bone and the umbilicus.
- c) Distance 3 Anterior superior iliac spine of left hip bone and the umbilicus.

Assessment was done before treatment and after the last session program 14.

3- Skin laxity:

a- The Pittsburgh Rating Scale:

Skin laxity severity assessment was performed using the Pittsburgh Rating Scale across all female participants in groups A and B during pre and post-treatment phases.

The Pittsburgh scale ranges from zero to three, where zero represents normal appearance, one signifies mild deformity, two indicates moderate deformity, and three denotes the most severe deformity level. The scale incorporates these criteria: zero equals Normal, one equals Redundant skin with rhytids or moderate adiposity without overhang, two equals Overhanging pannus, three equals Multiple rolls or epigastric fullness¹⁵.

b- Digital photography scale:

Digital photography scale was used to take photos for the site of skin laxity for all females to assess percentage of improvement of skin laxity in both groups (A & B) before and after treatment.

Patients were instructed to assume a comfortable supine position and the therapist take photos for the site of skin laxity at the same room lighting and identical camera settings and compared the photos before and after the treatment to assess the percentage of improvement¹⁶.

A- Treatment procedures:

1- Tretinoin cream (Retin-A cream):

It was used for treatment of all females in both groups (A&B).

Tretinoin cream was used on abdomen once every other day for 8 weeks

2- Radiofrequency (Hexapolar):

It was used for treatment of all females in group B.

Radiofrequency was applied for 30-40 minutes/ session, 2 times/week for 8 weeks.

Skin preparation:

The skin should be free of oils and lotions and should be cleaned prior to radiofrequency application.

Radiofrequency technical steps:

- Before the start of treatment session, every female was instructed briefly and clearly about the mechanism of radiofrequency and its effect in order to gain their confidence and cooperation through the period of the study.
- The female was lying in relaxed supine lying position.
- The head of radiofrequency was cleaned by antiseptic solution.
- The gel covered the abdominal area at the site of skin laxity.
- The device was switched on and the treatment was applied by the radiofrequency head through circular and regular movements slowly on the abdominal area.
- The temperature was modified according to the sensation of the patient.
- It was applied for 30-40 minutes/session according to the severity of skin laxity 2 times per week for 8 weeks.
- After the end of treatment session, the therapist switched off the device.
- The treated area was checked to see if there was a marked erythema.
- After the treatment ended, all measurements of each patient were taken for a comparison.



Fig. (1): Application of RF.

Statistical analysis:

Statistical analysis involved multiple testing procedures. Unpaired t-tests facilitated inter-group subject characteristic comparisons. Data normality was verified through Shapiro-Wilk testing. Variance homogeneity assessment utilized Levene's test between groups. Mixed MANOVA analysis evaluated within and between-group effects on anatomical distance measurements including xiphoid process to umbilicus, right ASIS to umbilicus, and left ASIS to umbilicus. Multiple comparison procedures employed Bonferroni corrections. Mann-Whitney U testing compared PRS and digital photography scales between groups, while Wilcoxon signed ranks testing assessed pre-post treatment changes. Statistical significance was defined as $p < 0.05$ across all analyses. Data analysis utilized SPSS version 25 for Windows (IBM SPSS, Chicago, IL, USA).

Results:

I- General characteristics of the subjects:

Inter-group comparisons of general participant characteristics revealed no statistically significant differences in age, weight, height, and BMI parameters ($p > 0.05$) (Table 1).

Table (1): Comparison of age, weight, height and BMI between group A and B.

	Group A	Group B	MD	t- value	P- value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Age (years)	19.60 ± 1.22	20.03 ± 0.85	-0.43	-1.59	0.12	NS
Weight (kg)	67.63 ± 5.06	67.83 ± 5.89	-0.2	-0.14	0.89	NS
Height (cm)	159.43 ± 4.70	158.87 ± 6.12	0.56	0.40	0.69	NS
BMI (kg/m ²)	26.57 ± 0.99	26.83 ± 1.14	-0.26	-0.94	0.35	NS

\bar{X} : Mean
t value: Unpaired t value
SD: Standard deviation
p value: Probability value
MD: Mean difference
NS: Non significant

II- Two point discrimination:

Within groups; there was significant decrease in two point discrimination (Distance between Xiphoid process and umbilicus, Right ASIS and umbilicus & Left ASIS and umbilicus) post treatment in both groups (A and B).

Between groups; pre treatment; there was no significant difference between both groups (A and B) in two point discrimination. While, post treatment; there was significant difference between both groups (A and B) in two point discrimination (Distance between Xiphoid process and umbilicus, Right ASIS and umbilicus & Left ASIS and umbilicus) (with favor of group B) (Table 2).

Table (2): Two point discrimination(Distance between Xiphoid process and umbilicus, Right ASIS and umbilicus & Left ASIS and umbilicus):

	Group A	Group B	MD	p value	Sig
	Mean ±SD	Mean ±SD			
Distance (cm)					
Xiphoid process and umbilicus					
Pre treatment	16.83 ± 1.82	16.97 ± 1.75	-0.14	0.77	NS
Post treatment	15.73 ± 1.64	14.40 ± 1.35	1.33	0.001	S
MD	1.10	2.57			
% of change	6.54	15.14			
p value	p = 0.001	p = 0.001			
Right ASIS and umbilicus					
Pre treatment	18.50 ± 2.15	18.43 ± 2.34	0.07	0.91	NS
Post treatment	17.53 ± 1.98	15.60 ± 1.45	1.93	0.001	S
MD	0.97	2.83			
% of change	5.24	15.36			
p value	p = 0.001	p = 0.001			
Left ASIS and umbilicus					
Pre treatment	19.93 ± 1.98	20.30 ± 2.18	-0.37	0.49	NS
Post treatment	18.77 ± 1.96	17.23 ± 1.76	1.54	0.002	S
MD	1.16	3.07			
% of change	5.82	15.12			
p value	p = 0.001	p = 0.001			

\bar{X} : Mean
difference
SD: Standard deviation
MD: Mean

p value: Probability value

S: Significant

NS: Non significant

III- Skin laxity using PRS and Digital photography scale:

Within-group analysis revealed significant Pittsburgh rating scale reductions and significant digital photography scale increases post-treatment in both groups (A and B).

Inter-group comparisons showed no significant differences between groups (A and B) in Pittsburgh rating scale and digital photography scale pre-treatment. However, post-treatment comparisons demonstrated significant differences between groups (A and B) in both Pittsburgh rating scale and digital photography scale, favoring group B (Table 3).

Table (3): Skin laxity using PRS and Digital photography scale pre and post treatment of group A and B:

	Group A	Group B	U-value	p value	Sig
	Median (IQR)	Median (IQR)			
PRS					
Pre- treatment	1 (2-1)	1 (2-1)	435	0.78	NS
Post- treatment	1 (1-0)	0 (0-0)	195	0.001	S
Z- value	-4.47	-5.04			
P-value	p = 0.001	p = 0.001			
Sig	S	S			
Digital photography scale					
Pre- treatment	0 (0-0)	0 (0-0)	450	1	NS
Post- treatment	1 (1-0)	2 (3-3)	110	0.001	S
Z- value	-5.15	-4.89			
P-value	p = 0.001	p = 0.001			
Sig	S	S			

IQR: Interquartile range S: Significant Z- value: Wilcoxon signed ranks test value p value: Probability value U- value: Mann-Whitney test value NS: Non significant

Discussion:

The skin represents the body's outermost organ, and its appearance shapes patient personality. Dermatological conditions and aesthetic concerns substantially impact self-esteem¹⁷.

Diminished collagen quantity and quality in dermal and hypodermal layers represents a fundamental cause of laxity and cellulite. The influence of these conditions on patient self-confidence can become substantial enough to affect life quality in psychological and sociocultural aspects. Treatment demand for skin laxity is expanding as aesthetic standards become progressively rigorous¹⁸.

Aesthetic radiofrequency devices for body skin tightening, cellulite reduction, wrinkle treatment, and body contouring applications are gaining popularity in clinics globally due to their proven efficacy and safety, combined with minimal complications and downtime. Patients can resume normal activities immediately¹⁹.

Surgical cosmetic procedures remain the gold standard intervention for cutaneous laxity management. Nevertheless, for patients seeking non-surgical alternatives or those with occupational scheduling constraints, hexapolar radiofrequency (RF) technology represents an optimal minimally invasive option for soft tissue enhancement²⁰.

This study was conducted to determine the effect of of hexa-polar radiofrequency on abdominal skin laxity post weight reduction in obese adolescent females.

Sixty overweight and obese adolescent females complaining of post weight reduction skin laxity participated in this study.

They were divided randomly into two equal groups: Group A (Control group): It was consisted of thirty adolescent females and were treated by tretinoin cream (Retin-A) on abdomen once every other day for 8 weeks.

Group B (Study group): It was consisted of thirty adolescent females and were treated by tretinoin cream (Retin-A) on abdomen: once every other day for 8 weeks in addition to hexa-polar radiofrequency for 30-40 minutes/ session, 2 times/week for 8 weeks.

Tape measurement was used to assess two-point discrimination through measuring the distance between two specific points in the treatment area to measure the difference between them before and after the treatment. Pittsburgh rating scale was used to assess severity of abdominal skin laxity. Digital photography scale was used to assess percentage of improvement of skin laxity for all females in both groups (A&B) before and after treatment.

Results of this study found that; between groups; pre treatment; there was no significant difference between both groups (A and B) in two point discrimination, Pittsburgh rating scale and digital photography scale. While, post treatment; there was significant difference between both groups (A and B) in two point discrimination, Pittsburgh rating scale and digital photography scale (with favor of group B).

The results of the present study can be explained by the mechanism of RF which based on delivering RF waves to the tissue layers, generating thermal energy that triggers a cascade of events including collagen contraction, coagulation, matrix remodeling, and ultimately increased dermal thickness. As RF energy is not absorbed by chromophores, devices can be used in all skin types. The first generation of devices had drawbacks for the patients, such as excess pain, but newer-generation devices have cooling systems or different electrode organization that deliver heat homogeneously for increased efficiency and patient comfort^{21,22}.

In²³ support the current study results by demonstrating that RF technology generates electric current, creating heat through dermal resistance extending into subcutaneous fat layers. This thermal energy induces collagen contraction and activates fibroblasts to synthesize new collagen fibers. These combined mechanisms produce circumferential decrease and enhance skin laxity and cellulite appearance. Also, documented that RF application activates mediators including transforming growth factor beta (TGF- β), resulting in neocollagenesis. The subsequent healing phase involves collagen remodeling, ultimately renewing facial contours and achieving long-term skin tightening.

Local circulation improvement occurs through vasodilation and enhanced lymphatic drainage. Clinical outcomes include reduced laxity and improved skin surface regularity²⁴.

Additionally, in²² findings align with this study's results, reporting that energy sources commonly used in devices include laser, ultra sound, broad band light and radiofrequency (RF) claiming skin and soft tissue tightening. Sadick presented the recommendation that RF is the best for tissue tightening.

The results of this study are in agreement with²⁵ who performed research involving 35 healthy female subjects with cutaneous laxity and subcutaneous adipose deposits in abdominal, gluteal, or thigh areas using innovative high-power radiofrequency technology combined with infrared light and mechanical manipulation. Results demonstrated that 60% of subjects showed 24.1% improvement, 27% exhibited 25-49% improvement, 5% achieved 50-74% improvement, while only 8% displayed no improvement.

Moreover,²⁶ findings support this study by demonstrating that RF application effects on connective fibers, including collagen and elastic fibers, suggest spatial rearrangement without complete denaturation.

The result of this study in agreement with the findings of²⁶ who observed a significant rise in the use and importance of RF devices within the field of aesthetic treatments.

In²⁷ findings corroborate this study's outcomes by discovering that numerous factors, in combination with modern aesthetic patients' dynamic lifestyles and their preference for noninvasive therapeutic alternatives, have enhanced the popularity of noninvasive, nonsurgical therapeutic methodologies, including non-invasive hexa-polar RF.

This investigation's findings correspond with²⁷, who documented that RF delivers low RF energy to the deep dermis, elevating dermal temperature to 60-65°C while maintaining epidermal temperature at 40°C. The superpulsed mode and pulse width shorter than skin thermal relaxation time prevent pain or burns. Dermal heating produces collagen denaturation, leading to collagen fiber contraction. This mechanism provides immediate aesthetic improvement characterized by enhanced skin tightness and smoothness.

In ²⁸ findings additionally corroborate the investigation outcomes, establishing that RF treatments demonstrate safety and efficacy for circumferential diminishment and enhanced skin appearance in upper extremities and abdominal regions.

Also, ²⁹ utilized ex vivo human skin models to examine home-use device effects for skin tightening. Findings revealed substantial collagen remodeling following RF intervention using innovative home-use technology. Collagen density increased significantly across both superficial and deeper dermal tissue layers.

Current study findings align with ³⁰, who established multipolar RF safety and efficacy for managing upper extremity and abdominal tissue laxity.

The outcomes of our research corroborate those of ^{31, 32}, who found that RF devices provide a novel, non-invasive, and non-ablative method for enhancing contour and addressing skin laxity in the head, neck, and body.

The study's findings were consistent with those reported by ³³, who demonstrated that the use of a multipolar RF device offers a non-surgical, minimally invasive treatment capable of enhancing body contour, decreasing abdominal and thigh measurements, and improving the uneven, dimpled texture of the skin.

These outcomes receive additional confirmation from ³⁴, whose clinical investigation yielded exceptional overall enhancement in cutaneous laxity and circumferential diminishment, with complete absence of recovery periods for all participants. RF interventions demonstrate safety and efficacy for non-invasive face lifting, dermal tightening, and circumferential reduction across diverse skin types, with sustained positive results over extended periods.

In ³⁵ concur with these study findings, identifying RF skin tightening as an emerging and highly promising technique for non-surgical management of loose or pendulous skin. Their research indicates that the majority of patients experience at least modest improvement with minimal recovery duration and reduced risk exposure.

Consistent results appear in the work of ³⁶. They confirmed the effectiveness and safety of radiofrequency devices in stimulating dermal neocollagenesis. Epidermal integrity remains preserved throughout treatment. Additional benefits include enhanced tissue tightening.

Support for the current study outcomes comes from ²² who established that non-ablative cutaneous rejuvenation through radiofrequency technology offers low-risk, minimal-downtime treatment capable of improving skin laxity alterations while preserving dermal integrity.

The findings of this study contrast with those of ³⁷, who indicated that despite previous research demonstrating the safety and efficacy of radiofrequency in wrinkle reduction, it should not be regarded as a non-surgical lifting method for skin rejuvenation, as sometimes promoted falsely by some practitioners.

Strengths and limitations:

Throughout the study period, no negative consequences were observed in the current patient series ³⁷⁻⁴³. The non-invasive hexa-polar radiofrequency technique, randomized design, and calculated sample size are the strengths of this study. In addition, the study used skin fold thickness as an objective assessment. However, it was conducted without patient follow-up. So, further research is required to determine how hexa-polar radiofrequency will effect on abdominal skin laxity post weight reduction in obese adolescent females and its symptoms over the long term with patient follow-up.

CONCLUSION:

It could be concluded that hexa-polar radiofrequency is an effective method in reducing abdominal skin laxity post weight reduction in obese adolescent females.

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Author contributions:

All authors conducted the idea, research design, data gathering, statistical analysis, and data interpretation. They collaborated to write, revise, and approve the final manuscript before publication.

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