



Original Article

Effects of radiofrequency, electroacupuncture, and low-level laser therapy on the wrinkles and moisture content of the forehead, eyes, and cheek

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Abstract. [Purpose] The purpose of this study was to investigate the effects of radiofrequency (RF), electroacupuncture (EA), and low-level laser therapy (LLLT), which are used in physical therapies, on facial wrinkles and moisture. [Subjects and Methods] A total of 30 female participants aged 30–55 years participated in this study and the results will be used as a reference for further development of skin physical therapy. Thirty adult females were assigned to an LLLT (n=10), EA (n=10), or RF group (n=10). The intervention was performed in two 15-minute sessions per week for six weeks. Subjects' skin tone and pigmentation were observed before and after the intervention. [Results] Treatment of the under eye area showed that wrinkles were significantly decreased on both sides after RF, EA, and LLLT. Treatment of the eye rims indicated that wrinkles significantly decreased on the right side after RF, EA, and LLLT. [Conclusion] The application of LLLT, EA, and RF had positive effects on wrinkle and moisture content of adult women's faces.

Key words: Low-level laser therapy, Wrinkles, Moisture

(This article was submitted Oct. 19, 2016, and was accepted Nov. 7, 2016)

INTRODUCTION

Aging is a gradual process, proportional to time, that causes structural and functional changes due to internal degeneration. It causes a decrease in the ability to react to environmental stimuli. Aging can be divided into intrinsic aging, which is natural with the progression of time, and environmental aging caused by the external environment. Photoaging caused by UV rays is the most representative cause of environmental aging¹⁾.

UV-induced photoaging is usually observed on skin that is exposed to the sun. Its clinical characteristics include earlier observation than intrinsic aging, deep and wide wrinkles, inconsistent pigmentation and solar lentigo on the exposed skin surface²⁾.

Along with recent socio-financial improvements, improvements in medical technology, hygiene and nutrition have increased life expectancy. As the elderly population increases, so does research interest into aging³⁾. Many treatment methods to reduce skin aging and improve wrinkles and pores are currently being researched^{4, 5)}. However, ablative laser treatment causes a financial burden and side effects, such as erythema, edema, and hyperpigmentation. In addition, the damage on the epidermis caused by ablative laser treatment delays the time between returning to daily activities^{6–8)}. Recently, non-ablative skin rejuvenation, which improves skin aging and photoaging without damaging the epidermis, has been the preferred treatment⁹⁾.

Previous studies suggest that radiofrequency (RF) effectively reduces abdominal obesity by transferring heat to the dermis, increases blood volume in the capillaries and hence increases blood flow, induces collagen formation, and increases the thick-

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Table 1. General characteristics

| Variables | LLLT (n=10) | EA (n=10) | RF (n=10) |
|-------------|----------------|--------------|--------------|
| Age (years) | 42.9 ± 3.7 | 43.4 ± 7.1 | 42.8 ± 4.9 |
| Height (cm) | 159.8 ± 4.3 | 158.0 ± 4.3 | 163.0 ± 7.9 |
| Weight (kg) | 52.4 ± 6.1 | 58.8 ± 7.2 | 56.7 ± 7.5 |

Values are shown as the mean ± SD, $p < 0.05$. LLLT: low-level laser therapy group; RF: radiofrequency group; EA: electroacupuncture group

Table 2. Moisture rate

| Variables | Forehead | Cheek |
|-------------------------------|----------|-------|
| Very dry (AU) | 1–24 | 1–24 |
| Dry (AU) | 25–34 | 25–34 |
| Moisturized (AU) | 35–44 | 35–44 |
| Sufficiently moisturized (AU) | 45–65 | 45–65 |

AU: Arbitrary unit

ness of the epidermis^{10–12}). Electroacupuncture (EA) has been reported to reduce inflammation, induce healing of damaged tissues, reduce pain, and improve facial rejuvenation^{13–15}. Low-level laser therapy (LLLT) has been used in various research studies and has been reported to have anti-inflammatory effects, reduce pain, reduce edema, induce healing of damaged tissue or fracture, produce collagen, induce skin rejuvenation and to be effective for acne and vitiligo^{16–21}.

In this study, the effects of RF, EA, and LLLT on wrinkles and moisture content were investigated in 30 female subjects aged 30–55 years. The results will be used as a reference for the further development of skin physical therapy.

SUBJECTS AND METHODS

The subjects of this study were 30 adult women aged between 30 and 55 years who presented at M Dermatology Hospital in Yongin, Gyeonggi-do, South Korea and who voluntarily agreed to participate after listening to an explanation of the purpose of the study. The subjects were assigned to RF, (n=10), EA (n=10) or LLLT (n=10) groups. The intervention was performed in two 15-minute sessions per week for six weeks. Wrinkles and moisture content were observed pre and post intervention. Inter-group homogeneity testing for general characteristics prior to treatment revealed no significant differences. Written informed consent was obtained from each subject. The Ethics Committee of Namseoul University, South Korea approved the study (IRB approval number: 104147-201504-HR-003). The characteristics of the subjects are shown in Table 1.

For the RF group, PRX III (SHENB Co., Ltd., Korea) was used at 1 MHz (RF energy, maximum 450W/cm²) in two 15-minute sessions per week for six weeks²². For the EA group, disposable stainless steel acupuncture (0.20 × 15mm) was used. For EA stimulation, an OTS H-306 (HANIL TM Co., Ltd., Korea) was used at a frequency of 3 Hz, with 5 seconds of on time and 2 seconds of off time. The intensity of the EA was increased until the subject felt stimulation and a small muscular contraction and was then maintained. For the LLLT group, RedPulsar (SOMETECH Inc., Korea), which is a diode laser, was used in two 15-minute sessions per week for six weeks at 635 nm, with 10mW of the laser class IIIb²³.

A JANUS skin measurement device (PSI Co., Ltd., Korea) was used in this study. The faces of the subjects were fixed in a specific spot and the facial skin conditions were meticulously photographed using a 10 megapixel Canon DSLR camera lens. Wrinkles under both eyes were measured through front-view photos, whereas wrinkles on the eye rims were measured through profile-view photos. To minimize the measurement errors, the same rater performed measurements from the beginning to the end in similar indoor environments (room temperature 20–21 °C and humidity 50–60%).

A moisture checker (PSI Co., Ltd., Korea) was used to measure the skin moisture levels on the forehead and right cheek. In order to reduce error, three measurements were taken and the average was calculated (Table 2).

All data were coded and analyzed using the SPSS statistical analysis program (ver.18). To determine the post-intervention changes in the number of wrinkles and moisture content in each group, a test of normality was conducted. If subjects passed the test, a paired samples t-test was conducted; otherwise, the Wilcoxon rank-sum test was conducted. To determine the inter-group differences in wrinkles and moisture content, one-way analysis of variance was used when they satisfied normality. Otherwise, their significance was verified by the Kruskal-Wallis test. The statistical significance level was $p < 0.05$ for all data.

RESULTS

Treatment of under eyes showed that wrinkles have significantly decreased on both sides after RF, EA and LLLT ($p < 0.05$). Treatment of eye rims showed that wrinkles have significantly decreased on the right side after RF, EA and LLLT ($p < 0.05$) (Table 3).

Treatment of forehead showed that skin moisture has significantly increased after RF, EA and LLLT ($p < 0.05$). Treatment of cheek showed that skin moisture has significantly increased after RF, EA and LLLT ($p < 0.05$). Significant differences have been observed on skin moistures of the cheek between the two groups ($p < 0.05$) (Table 4).

Table 3. Changes in the number of wrinkles after RF, EA or LLLT and a comparison of wrinkle improvements between groups

| Wrinkles | Intervention | Pre | Post |
|------------|------------------------|------------|------------|
| Under eyes | RF* | 11.2 ± 2.8 | 8.3 ± 3.6 |
| | ^a Right EA* | 14.7 ± 9.5 | 10.7 ± 7.3 |
| | LLLT* | 14.4 ± 6.2 | 11.3 ± 4.4 |
| | RF* | 12.9 ± 4.5 | 8.0 ± 3.3 |
| | ^b Left EA* | 16.5 ± 8.9 | 13.0 ± 7.3 |
| | LLLT* | 12.7 ± 5.8 | 10.1 ± 4.6 |
| Eye rims | RF* | 8.1 ± 4.1 | 6.0 ± 3.1 |
| | ^a Right EA* | 12.3 ± 8.1 | 9.8 ± 5.9 |
| | LLLT* | 7.6 ± 3.7 | 6.6 ± 2.9 |
| | RF | 7.9 ± 5.2 | 6.8 ± 4.3 |
| | ^b Left EA | 13.0 ± 8.2 | 11.2 ± 6.7 |
| | LLLT | 7.7 ± 4.0 | 6.6 ± 3.8 |

Values are shown as the mean ± standard deviation, *Significant difference between the pre- and post-tests within each group, p<0.05. ^aPaired Samples T-test; ^bWilcoxon Rank-Sum test; RF: radiofrequency; EA: electroacupuncture; LLLT: low-level laser therapy

Table 4. Changes in skin moisture after RF, EA or LLLT and comparison of skin moisture improvements between groups

| Moisture content | Intervention | Pre | Post |
|--------------------------------------|--------------|------------|------------|
| ^a Forehead | RF* | 35.3 ± 2.5 | 37.1 ± 3.0 |
| | EA* | 33.7 ± 3.8 | 38.7 ± 3.2 |
| | LLLT | 32.9 ± 4.8 | 36.9 ± 4.9 |
| ^a Cheek ^{2<1} | RF* | 36.3 ± 2.9 | 38.9 ± 2.5 |
| | EA* | 33.7 ± 3.6 | 41.5 ± 3.5 |
| | LLLT* | 34.5 ± 2.9 | 39.9 ± 3.3 |

Values are shown as the mean ± standard deviation, *Significant difference between the pre- and post-tests within each group, p<0.05. ^aPaired Samples T-test; ^bWilcoxon Rank-Sum test; LLLT: low-level laser therapy; EA: electroacupuncture; RF: radiofrequency; 1: RF; 2: EA; 3: LLLT

DISCUSSION

Desire for anti-aging and antioxidants has increased with economic growth and life expectancy. Active participation of females in all aspects of society has increased the attention paid to skin management^{3, 21}). Therefore, this study aimed to investigate the effects of RF, EA and LLLT on wrinkles and skin moisture content.

A previous study by El-Domyati et al.¹⁰), which conducted a quantitative evaluation of dermal collagen after RF treatment, reported an increase in type I and type II collagens and a decrease in the number of wrinkles under the eyes and on the eye rims (p<0.01). A study by Abraham et al.²⁴) also reported improvements in wrinkles, pore size, and the laxity of facial skin. The present study reported similar findings in that wrinkles under the eyes and on the eye rims were significantly decreased (p<0.05). Based on previous studies that reported that RF induces the formation of new collagen by transferring heat to the dermis^{25, 26}), we hypothesize that the formation of new collagen contributed to the improvement of wrinkles under the eyes and on the eye rims in this study.

Barrett¹⁴) reported that the number of wrinkles on eye rims decreased by 50% and wrinkles under the eyes decreased by 20% after 10 sessions of EA. Kwon et al.²⁷) reported that miso facial rejuvenation acupuncture significantly decreased the width of wrinkles on eye rims from 4.87 ± 3.63 to 2.43 ± 2.04. Using Jae-Seng acupuncture, Cho et al.²⁸) reported significant improvements in the number of eye wrinkles, consistent with the present study (p<0.001).

A previous study by Barolet et al.²⁹), in which 12 LED treatments at 660 nm, 50 mW/cm and 4 J/cm² were conducted on a 3D model of tissue-engineered human reconstructed skin, reported improvements in wrinkle depth, surface roughness and Fitzpatrick wrinkling severity scores. Russell et al.³⁰) incorporated combination LED light therapy (633 nm and 830 nm) and also reported improvements in periorbital wrinkles. In the present study, wrinkles under the eyes on both sides and wrinkles on the left eye rims were significantly decreased after LLLT treatment (p<0.05). Based on previous studies, which reported

that LLLT treatment induced collagen up regulation and down-regulation of matrix metalloproteinase, it can be inferred that the increase in collagen on the epidermis contributed to the improvement of wrinkles.

Kwon et al.³¹⁾ reported that the moisture content of the right side of the face increased from 49.10 ± 10.95 AU to 63.20 ± 12.42 AU after miso facial rejuvenation acupuncture ($p < 0.001$). In the present study, the moisture content improved significantly on the forehead and the cheek in the EA group ($p < 0.05$). A previous study by Oh et al.³²⁾ reported that the relaxation of the skin and the wrinkles increased as aging progresses since the moisture content decreases. Therefore, it can be inferred that the increase in the moisture content observed in the present study was caused by the decrease in wrinkles.

There were several limitations to this study. Firstly, since the study was not conducted on a large number of participants and it was only conducted on female adults between the ages of 30–55 years, generalization of the results is limited. Secondly, since the study only confirmed the effects in a span of 6 weeks, evaluation of long-term effects was not possible. Therefore, further studies should be conducted on a larger sample pool composed of female participants from a larger age range, and long-term effects should be confirmed during a span of at least 6 months.

ACKNOWLEDGEMENT

The funding for this study was provided by Namseoul University.

REFERENCES

- 1) Fisher GJ, Kang S, Varani J, et al.: Mechanisms of photoaging and chronological skin aging. *Arch Dermatol*, 2002, 138: 1462–1470. [Medline] [CrossRef]
- 2) Brenneisen P, Wlaschek M, Schwaborn E, et al.: Activation of protein kinase CK2 is an early step in the ultraviolet B-mediated increase in interstitial collagenase (matrix metalloproteinase-1; MMP-1) and stromelysin-1 (MMP-3) protein levels in human dermal fibroblasts. *Biochem J*, 2002, 365: 31–40. [Medline] [CrossRef]
- 3) Fort AT: State of the art in anti-aging trends. *Clin Geriatr Med*, 2011, 27: 507–522. [Medline] [CrossRef]
- 4) Freeman MS: Microdermabrasion. *Facial Plast Surg Clin North Am*, 2001, 9: 257–266, viii. [Medline]
- 5) Coimbra M, Rohrich RJ, Chao J, et al.: A prospective controlled assessment of microdermabrasion for damaged skin and fine rhytides. *Plast Reconstr Surg*, 2004, 113: 1438–1443, discussion 1444. [Medline] [CrossRef]
- 6) Goldberg DJ: Current trends in intense pulsed light. *J Clin Aesthet Dermatol*, 2012, 5: 45–53. [Medline]
- 7) Kim S, Cho KH: Clinical trial of dual treatment with an ablative fractional laser and a nonablative laser for the treatment of acne scars in Asian patients. *Dermatol Surg*, 2009, 35: 1089–1098. [Medline] [CrossRef]
- 8) Alexiades-Armenakas MR, Dover JS, Arndt KA: The spectrum of laser skin resurfacing: nonablative, fractional, and ablative laser resurfacing. *J Am Acad Dermatol*, 2008, 58: 719–737, quiz 738–740. [Medline] [CrossRef]
- 9) Weiss RA, McDaniel DH, Geronemus RG: Review of nonablative photorejuvenation: reversal of the aging effects of the sun and environmental damage using laser and light sources. *Semin Cutan Med Surg*, 2003, 22: 93–106. [Medline] [CrossRef]
- 10) el-Domyati M, el-Ammawi TS, Medhat W, et al.: Radiofrequency facial rejuvenation: evidence-based effect. *J Am Acad Dermatol*, 2011, 64: 524–535. [Medline] [CrossRef]
- 11) Kim JS, Oh DW: Effects of high-frequency current therapy on abdominal obesity in young women: a randomized controlled trial. *J Phys Ther Sci*, 2015, 27: 31–33. [Medline] [CrossRef]
- 12) Paul M, Blugerman G, Kreindel M, et al.: Three-dimensional radiofrequency tissue tightening: a proposed mechanism and applications for body contouring. *Aesthetic Plast Surg*, 2011, 35: 87–95. [Medline] [CrossRef]
- 13) Parmen V, Taulescu M, Ober C, et al.: Influence of electroacupuncture on the soft tissue healing process. *J Acupunct Meridian Stud*, 2014, 7: 243–249. [Medline] [CrossRef]
- 14) Barrett JB: Acupuncture and facial rejuvenation. *Aesthet Surg J*, 2005, 25: 419–424. [Medline] [CrossRef]
- 15) Goldman N, Chen M, Fujita T, et al.: Adenosine A1 receptors mediate local anti-nociceptive effects of acupuncture. *Nat Neurosci*, 2010, 13: 883–888. [Medline] [CrossRef]
- 16) Kim GY, Kim EJ: Anti-inflammation effects of low intensity laser therapy on monosodium iodoacetate-induced osteoarthritis in rats. *J Phys Ther Sci*, 2013, 25: 173–175. [CrossRef]
- 17) Fabre HS, Navarro RL, Oltramari-Navarro PV, et al.: Anti-inflammatory and analgesic effects of low-level laser therapy on the postoperative healing process. *J Phys Ther Sci*, 2015, 27: 1645–1648. [Medline] [CrossRef]
- 18) Kim HK, Min KO, Choi JH, et al.: Effects of low-level laser therapy, electroacupuncture, and radiofrequency on the pigmentation and skin tone of adult women. *J Phys Ther Sci*, 2016, 28: 1407–1411. [Medline] [CrossRef]
- 19) Koo HM, Yong MS, Na SS: The effect of low-intensity laser therapy (LILT) on cutaneous wound healing and pain relief in rats. *J Phys Ther Sci*, 2015, 27: 3421–3423. [Medline] [CrossRef]
- 20) Chang WD, Lin HY, Lai PT: The effects of phototherapy of an 808 nm diode laser on bone fracture. *J Phys Ther Sci*, 2012, 24: 695–697. [CrossRef]
- 21) Avci P, Gupta A, Sadasivam M, et al.: Low-level laser (light) therapy (LLLT) in skin: stimulating, healing, restoring. *Semin Cutan Med Surg*, 2013, 32: 41–52. [Medline]
- 22) Choi HG, Lyu JY, Im GH, et al.: The effect of high-frequency care and ultrasonic care on pigmentation and wrinkles. *Kor Aesthet Soc*, 2008, 6: 11–19.
- 23) Lee SY, You CE, Park MY: Blue and red light combination LED phototherapy for acne vulgaris in patients with skin phototype IV. *Lasers Surg Med*, 2007, 39: 180–188. [Medline] [CrossRef]

- 24) Abraham MT, Chiang SK, Keller GS, et al.: Clinical evaluation of non-ablative radiofrequency facial rejuvenation. *J Cosmet Laser Ther*, 2004, 6: 136–144. [[Medline](#)] [[CrossRef](#)]
- 25) Sarradet MD, Hussain M, Goldberg DJ: Electrosurgical resurfacing: a clinical, histologic, and electron microscopic evaluation. *Lasers Surg Med*, 2003, 32: 111–114. [[Medline](#)] [[CrossRef](#)]
- 26) England LJ, Tan MH, Shumaker PR, et al.: Effects of monopolar radiofrequency treatment over soft-tissue fillers in an animal model. *Lasers Surg Med*, 2005, 37: 356–365. [[Medline](#)] [[CrossRef](#)]
- 27) Kwon NH, Kim CY, Shin YJ, et al.: Clinical study on facial skin furrow measurement changes after miso facial rejuvenation acupuncture. *J Kor acupu Moxibu Med Soc*, 2009, 26: 133–140.
- 28) Cho JH, Lee HJ, Chung KJ, et al.: Effects of Jae-Seng acupuncture treatment on the improvement of nasolabial folds and eye wrinkles. *Evid Based Complement Alternat Med*, 2015, 2015: 273909. [[Medline](#)] [[CrossRef](#)]
- 29) Barolet D, Roberge CJ, Auger FA, et al.: Regulation of skin collagen metabolism in vitro using a pulsed 660 nm LED light source: clinical correlation with a single-blinded study. *J Invest Dermatol*, 2009, 129: 2751–2759. [[Medline](#)] [[CrossRef](#)]
- 30) Russell BA, Kellett N, Reilly LR: A study to determine the efficacy of combination LED light therapy (633 nm and 830 nm) in facial skin rejuvenation. *J Cosmet Laser Ther*, 2005, 7: 196–200. [[Medline](#)] [[CrossRef](#)]
- 31) Kwon GS, Kim JH, Lee KA, et al.: The effect of miso facial acupuncture on facial reduction and improvement of skin condition. *J Kor acupu Moxibu Med Soc*, 29: 7–18.0.
- 32) Oh JH, Kim YK, Jung JY, et al.: Intrinsic aging- and photoaging-dependent level changes of glycosaminoglycans and their correlation with water content in human skin. *J Dermatol Sci*, 2011, 62: 192–201. [[Medline](#)] [[CrossRef](#)]