A Study on the Effectiveness of Skin Care Solution System using Non-Invasive Air Technology

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Abstract

The effectiveness of an innovative skin treatment system that delivers an anti-aging solution deep into the skin without invasiveness and pain using a non-invasive air technology was investigated. In addition, an effective change using a non-invasive technique for delivering a solution for skin improvement was confirmed.

The equipment named Cellre Jet is an effective skin care and drug delivery equipment that instantly opens the skin epidermis by using a maximum output pressure of 6 bars and high-pressure purified oxygen of 75-90% purity to deliver various nano-sized vital substances deep into the skin, and it uses the method of precisely controlling the equipment through an 8-inch digital touch display to accurately dispense the prescribed dosage.

In this study, changes in skin condition were analyzed using this equipment and nano ampoules on subjects with actual skin problems through a related comparison and effectiveness judgment program.

Through this study, skin care and drug delivery are possible, which will contribute to verifying the effectiveness of this non-invasive drug delivery equipment in the future, and is expected to establish the systematic effect in observing and studying changes in the skin.

Keywords: *Non-Invasive Air Technology, Drug Delivery System, Python, Nano Cosmetic, Skin Effectiveness*

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I. Introduction

Traditional skin care methods have been hand massage using hands. However, the development of science and technology has dramatically advanced the development of skin care equipment, and we are seeing an increase in the proportion of skin care equipment [1].

In addition, as technology-intensive products are being released, data emphasizing their effectiveness and performance are rising [2].

Care equipment originally used for the skin cleanses the skin, supply nutrients, restore the elasticity of the skin according to the purpose of use, and are effective in soothing and relieving, and equipment corresponding to these include HIFUs (high-frequency equipment, lifting equipment, galvanic equipment using electric current, and ultrasonic equipment using ultrasound) [3].

The range of options has been expanded to be able to use various equipment to beautify the skin for beautiful skin, and these options promote stagnant cells in the local area and change blood flow so that the product or drug can be absorbed well [4].

As we age, the skin of our 30s ages, and the stress associated with childbirth and child-rearing leads to hormonal changes, causing changes in the skin. It is the main cause of pigmentation and wrinkles, such as the dry effect of the skin, reduction of the skin oil, loss of elasticity, expansion of blood vessels, and spots and freckles [5,6].

Therefore, it is possible to cleanse the skin to remove various floating substances and wastes on the skin surface, supply oxygen and nutrients to the skin, increase metabolic activity, and increase absorption and delivery of cosmetics or drugs to make the skin soft and elastic, and we can prevent and delay skin aging by increasing the feeling of stability and reducing fatigue of the patient [7,8].

In this study, the effectiveness of an innovative skin treatment system that delivers an anti-aging solution deep into the skin without invasiveness and pain using the non-invasive air high-pressure injection technology was investigated.

In addition, this study was conducted to help the skin beauty industry by using the ampoule inserted into the equipment as the basic data for clinical validation through the actual use of the investigator's procedure and changes after the actual procedure.

II. Theoretical Background

As shown in Figure 1., we are used equipment of Mecca Co., Ltd. And the functional features of this device include: Using the non-invasive air high-pressure injection method consists of a body and a handpiece and has been manufactured with the principle of generating a liquid chemical drug solution at an instantaneous high pressure to apply pressure and sprays the ampoule and chemical solution in the form of fine particles to supply it to the skin.

At this time, the injected air is high-pressure purified oxygen, and a pure acid having a purity of 75 to 90% is used. In the case of the ampoules, various ampoules can be used, such as regeneration, acne removal, vitamin supply, hair care, and lifting.

Figure 1. CELLRE JET of Meca., Ltd.

The injection mode and output environment can be set through the 8-inch touch display interface used in the above equipment.

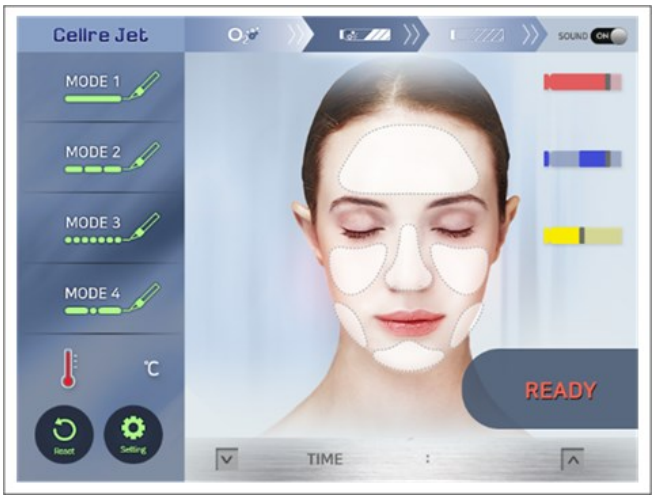

Figure 2. Screen of LCD Touch Display

As shown in Figure 2., the LCD touch display screen is divided into the mode setting, temperature display indicating the temperature change when the equipment is used, reset switch for initialization after replacing the ampoule of the equipment, setting switch for factory initialization of the equipment, progress display part to inform you each step of the treatment process, a sound on/off switch, standby switch to start air injection after all setting values have been changed, and lastly, time display part to indicate the remaining treatment time.

Figure 3. Components of Handpiece

In the case of the handpiece component shown in Figure 3., it is an equipment that combines oxygen generated from the main body of the equipment and the ampoule (oil ingredient) installed in the handpiece and sprays it on the skin in uniform and fine particles.

In addition, the rated voltage and frequency, power consumption, spray material, and heat dissipation method among the specifications of this equipment are shown in Table 1.

Table 1. Specification of equipment

Characteristics	Specification
Rated Voltage	220V
Frequency	60Hz
Power Consumption	150W
Spraying content	Air(O2)
Cooling Method	Air-Cooled

III. Research Method

3.1 Test Subjects

As for the test subjects, the test was conducted with test subjects who understood the purpose of the study and expressed their intention to participate; the test was conducted for 4 weeks, between April 04 to April 29, 2022, and after obtaining their consent, the test was conducted on one male and one female.

For the test procedure, the test was performed for a total of 3 times, and the selected test subjects were one man and one woman; one middle-aged man in his mid-40s, a woman in her mid-30s.

3.2 Test Protocol

The protocol used for the procedure prior to this test is shown 6 steps in Figure 4 and the equipment was set to MODE 1 for continuous operation, and high-pressure oxygen was supplied by selecting a spray high-pressure solvent, and the procedure was performed for about 10 minutes.

Figure 4. Protocol of Procedure

Step1 is properly remove all your makeup first.
Step2 is mount the ampoule to be used on the equipment.
Step3 is after basic setting work, it waits in standby state.
Step4 is treat with equipment where it is to be applied to the skin.
Step5 is after treatment, massage the skin.
Step6 is the skin condition before and after treatment is compared through image 3D plotting.

IV. Research Result

4.1 The Conditions of the Test Subjects' Skin Before and After

The skin of the two test subjects was treated initially by cleansing, then removing dead skin cells or oil, and spraying the ampoule afterward.

After performing the test, a total of 3 times, photos were taken to compare before and after.

Figure 5. Changes in Test Subject

As shown in Figure 5., the skin change of test subject 1 was improved dramatically, and in the case of inflammatory acne that occurred during the actual procedure, it was almost completely cured, achieving about 80% of the smoothing effect.

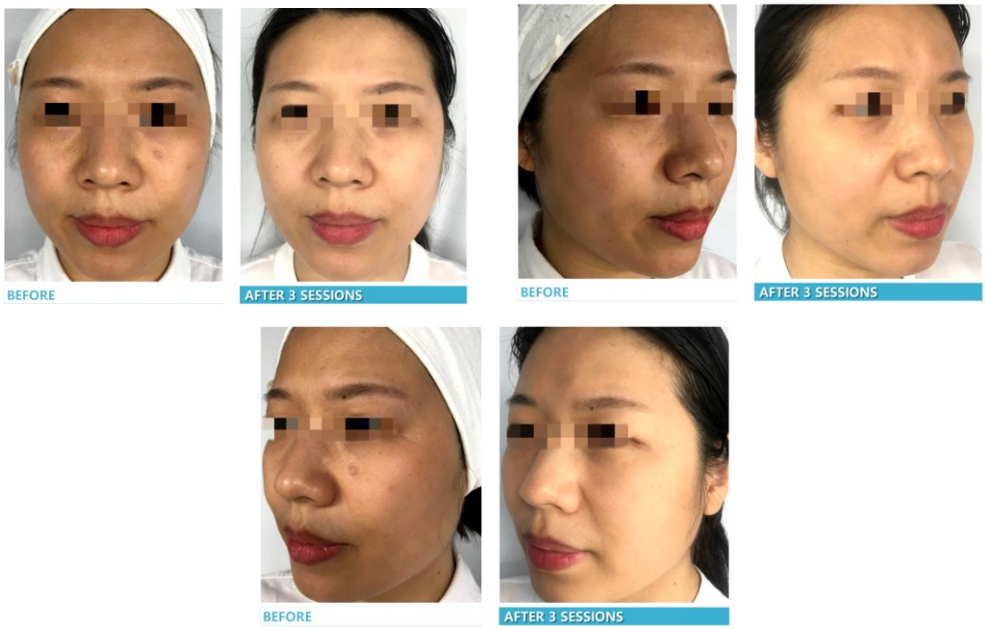

Figure 6. Changes of Test Subject 2

As shown in Figure 6., the skin change of test subject 2 resulted in the improvement of skin tone and removal of freckles and blemishes, and it was generally observed that the elasticity of the skin was increased.

However, it is true that it was difficult to judge the validity of the test through the subjective evaluation of appearance.

The changes in the skin trouble using the contrast of the images were transformed into 3D images and confirmed using the powerful Matplotlib function of Python to determine the treatment's effectiveness.

In recent years, in the field of computer vision, image recognition technology in units of frames within a moving picture has been dramatically developed.

For the evaluation of effectiveness this time, a photo file before and after the procedure was loaded to indicate the height of the contrast, and the roughness of the surface was physically expressed to confirm the effectiveness [9].

Python is software that can convert these 2D images into images that can be expressed in 3D, and the test was performed by importing the Matplotlib library. The code of the module used is as follows [10].

As shown in Figure 7., Matplotlib's 3D plot support module was imported to draw the 3D graphs, Numpy was used to process image pixel value arrays, and the Open cv module was created to read image files.

Image width and height were extracted by loading the image files before and after the tester's test, and the X, Y, Z values for 3D graph were defined.

```python
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
import cv2
def main():
    img_file = 'skin_tester2_after2.png'
    thres = 1

    img2 = cv2.imread(img_file, cv2.IMREAD_COLOR)
    wx, hy, rgb = img2.shape
    # print('wx:', wx, 'hy:', hy, 'rgb:', rgb)
```

```python
    xx = np.arange(wx)
    yy = np.arange(hy)
    zz = []
    for x in range(wx):
        for y in range(hy):
            zz.append(img2[x, y][0]/thres)
    # print(xx, yy, zz)

    X, Y = np.meshgrid(xx, yy)
    Z = np.asarray(zz, dtype=np.uint8).reshape((hy, wx))
    # Z = f(X, Y)
```

```python
    # Plotting 3D graph
    fig = plt.figure(figsize=(10, 6))
    ax = plt.axes(projection='3d')
    surf = ax.plot_surface(X, Y, Z, cmap='viridis', \
                           edgecolor='none', antialiased=True, \
                           linewidth=0)
    ax.set_xlabel('x')
    ax.set_ylabel('y')
    ax.set_zlabel('z')
    ax.set_zlim(0, 200)
    ax.set_title('3D surface plot for '+img_file, fontsize=20)

    # set view angles to get better plot
    ax.azim = 70   # z rotation (default=270)
    ax.elev = 50     # x rotation (default=0)
    ax.dist = 10    # zoom (define perspective)

    fig.colorbar(surf, shrink=0.5, aspect=15, pad = -0.05)
    plt.tight_layout()
    plt.savefig('3D_'+img_file)
    plt.show()
```

```python
# main 함수 로딩부
if __name__ == '__main__':
    main()
```

Figure 7. Validation Program Code

Finally, after setting the 3D projection to draw the graphs, the X, Y, and Z values were passed as parameters of the function, and the 3D viewing value was set by specifying the Cmap for color setting. After that, the results of the effectiveness judgment software are as follows.

The images shown in Figure 8. below show the height and depth extracted from the 2D images applied to the color map. From these images, it was possible to determine the degree of final relaxation of the skin by converting the changes in the skin surface into 3D graphs.

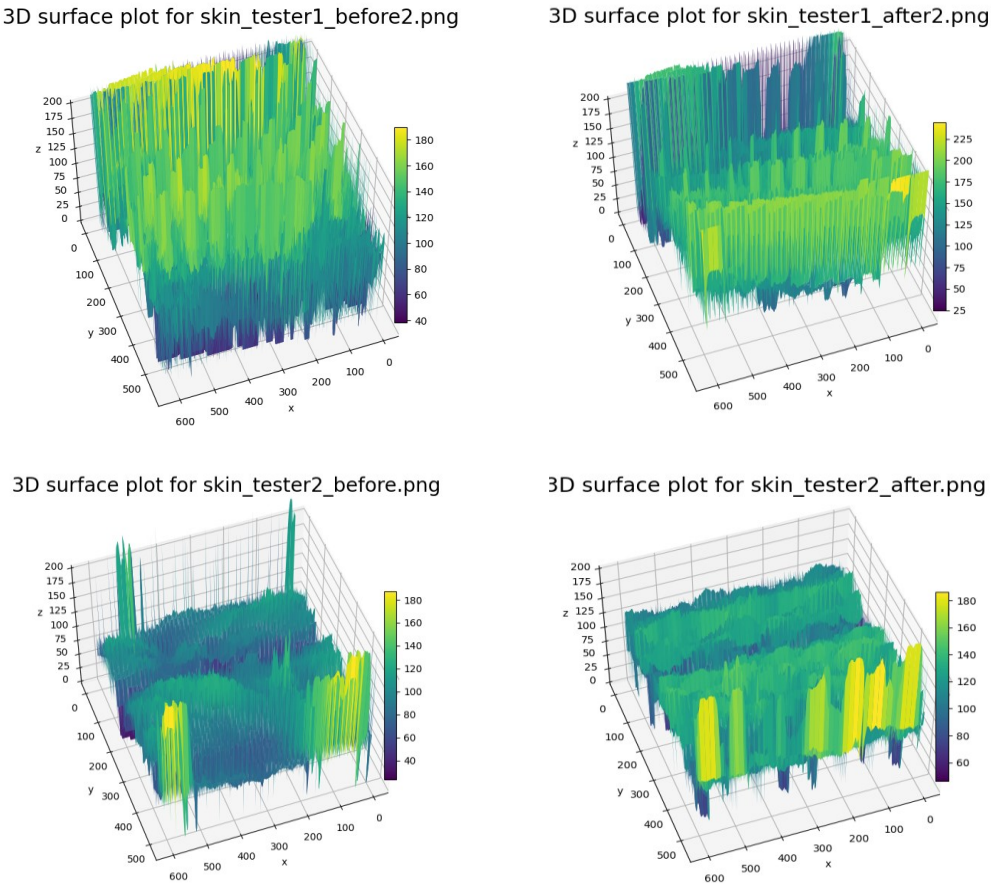

Figure 8. Validation Result

V. Conclusion

In this study, the effectiveness of an innovative skin treatment system that delivers an anti-aging solution deep into the skin without invasiveness and pain using a non-invasive hyperbaric oxygen pressure injection type product was verified.

The subjective effectiveness evaluation after the procedure was verified and implemented by 3D graphic processing of 2D images through the effectiveness judgment software.

It was an excellent opportunity to verify the effectiveness by measuring the performance of the device and changes after skin treatment in the future, and it is expected that the systematic effect of observing and researching changes in the skin will be investigated.

In addition, based on this study, it is possible to expand AI analysis and provision through diagnostic review after skin treatment, and I think that applied research on it will be developed.

VI. References

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