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Research Article

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FTIR Spectroscopic Study of Keloid Scar Using Silicone Gel Sheet

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1. Introduction

Wound healing in the human body, especially in the area of skin is a natural process. But wound healing is a well-orchestrated sequential process happening through four distinct steps such as hemostasis, inflammation, proliferation, and tissue remodeling [1]. But in some cases, excessive deposition of the extracellular matrix called collagen proteins found in the dermal layer of the skin causes scar. In the case of elders and adults, scar starts to grow in larger size called a keloid. Collagen proteins are the most abundant proteins found throughout the body. Collagen type I constitutes 80-85% of the dermal ECM, while collagen III constitutes 8-11% [2]. The Dermis layer contains a variable amount of fat, collagen, and elastic fibers that provide strength and flexibility to the skin [3]. The final healing phase is called remodeling, at this stage ECM and granulation tissue degrade via proteases, while mature type I collagenous matrix and scar tissue form [4]. Keloids can continue to grow over the years and even after the surgery, keloids tend to recur inevitably and the recurrence often exacerbates the condition [5]. From a histopathology perspective, keloids include a random organization of Type I and Type III collagen fibers, whereas hypertrophic scars have an organized parallel pattern of Type III collagen [6,7]. Although discovering the cellular processes that mediate keloid formation is still an active area of research, there is a wide variety of therapies that physicians can use to limit keloid formation, progression, recurrence, and symptoms [4]. One of the recent therapy methods that dermatologists included in the treatment plan is silicone gel sheets. In medicine, silicone gel sheets (SGS) play a very important role in flattening the keloid scar in humans. Which are made from medical-grade silicone, these sheets may help to flatten, and reduce the risk of excessive scar formation. SGS is composed of a semi-occlusive silicone gel sheet combined with a durable silicone membrane. They can help prevent a keloid from returning after another treatment like keloid surgery [8].

2. Description

2.1. Materials and Methods

SGS were bought from Amazon online in Chennai, Tamil Nadu, and India. The SGS before treatment of keloid patient was sent to MAEON Laboratories, Vanagaram, Chennai, for FTIR Spectrum recording. The SGS can be determined by Infrared spectrophotometry. The infrared spectrum of the test specimen is superimposed on a reference spectrum and compared for the determination of the SGS used. Aged person with keloid on her chest applied SGS on chest area for two weeks. After, the treatment SGS was collected and sent to Meaon laboratory, and the FTIR spectrum was recorded within the MID-IR region of 4000_600 cm^{-1}. The comparison study was done for before treatment SGS and after treatment SGS. FTIR spectroscopy can be used in qualitative analysis of keloid scar tissue by showing biomolecule changes in proteins, lipids, and nucleic acids.

3. Results and Discussion from FTIR Data

The bimolecular changes in the cell structures are measured using an FTIR spectrophotometer. ECM of keloid contains collagen I, collagen III, elastin fibrillin, fibronectin, hyaluronic acids, and Laminin. Keloids contain surplus amounts of collagen within the dermis, accounting for most of the bulk of the scar tissue [9]. Increased collagen expression caused by increased hydroxylation of proline residues in collagen molecules to form a triple helix configuration [10]. The infrared spectra of SGS

before treatment and after treatment of keloid patients were analyzed as follows. SGS before treatment FTIR-ATR spectra shown in Fig.1 Vibration bands at 2962.58 cm^{-1} and 2905.25 cm^{-1} caused by the asymmetric and symmetric stretching vibration of the Si-CH_3 methyl groups. Asymmetric and symmetric bending vibrations of the methyl groups are the origin for the absorption bands at 1410.34 cm^{-1} and 1258.41 cm^{-1}. Vibrations of the Si-O bonds generate strong absorption bands at 1079.26 cm^{-1} and Si-O-Si at 1007.59 cm^{-1} [11]. The band at 864.26 cm^{-1} due to vibrations of the methyl groups Si-CH_3, and the vibrations of the Si-C and Si-CH3 bonds cause the absorption bands as 785.43cm $^{-1}$ 700.87 cm^{-1}, 700.87 cm $^{-1}$ and 663.61 cm^{-1}.

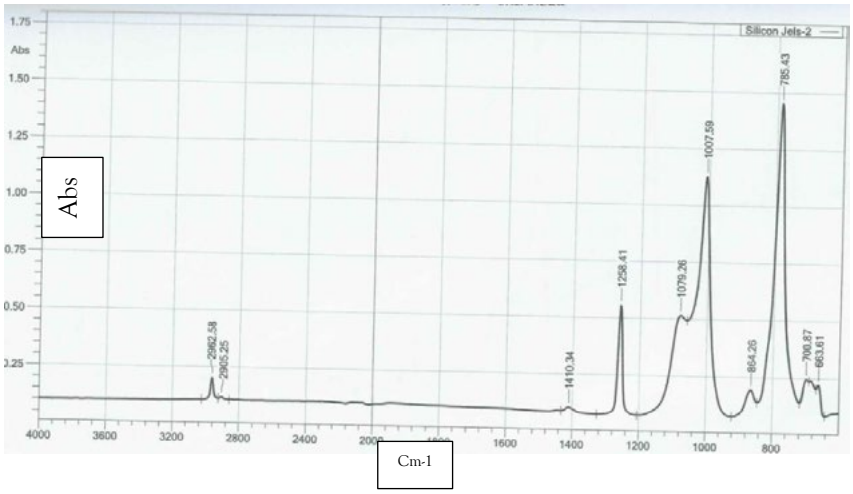

Figure 1: Silicone Gel Sheet Before Treatment FTIR-ATR Spectrum

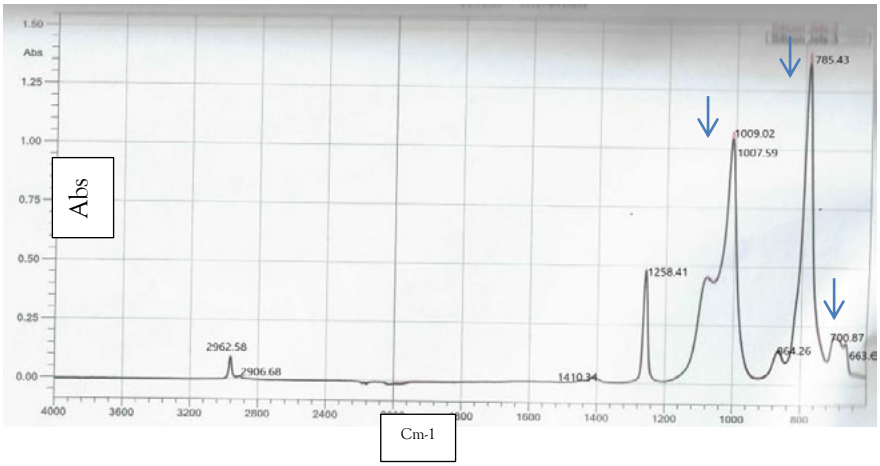

Figure 2: Overlay FTIR Spectra of before and after treatment of SGS

Then overlay FTIR spectra of before and after treatment SGS shown in Fig 2. From the overlay spectra wavenumbers at the peak 1009.02 cm^{-1}, 785.43 cm^{-1}, and 700.87 cm^{-1}, can show a remarkable difference in absorption and increase in the intensity levels. It's due to the presence of cytochrome C, phenylalanine. The absorbance peak at 1009.02cm^{-1} is due to the symmetric ring vibrational mode due to the presence of phenylalanine. The spectral variations in the intensity of the peaks at 750 cm^{-1}, 1125 cm^{-1}, and 1335 cm^{-1}, described to the heme group of Cyt C, (Cytochrome C) have the same sign between the perilesional and keloid fibroblast cells upon blue LED light irradiation. [12]. the peak at 1079.26 cm^{-1} represents the presence of nucleic acids, proteins, and carbohydrates.

4. Conclusion

Thus remarkable differences were observed in the spectra of before and after treatment of keloid scar using SGS. A higher level of collagen proteins in the keloid scar was observed. Thus FTIR spectroscopy is used to study the bimolecular changes that occur in keloid tissues.

References

1. Berman, B., Maderal, A., & Raphael, B. (2017). Keloids and hypertrophic scars: pathophysiology, classification, and treatment. *Dermatologic Surgery, 43,* S3-S18.
2. Evan Davison Kotler, Wiiliam S.Mrashall, Elena Gareta, Sources of Collagen for Biomaterilas in skin wound healing; Bioengineering 2019;6(3),56.
3. Ahmad Sukari Halim, Azadeh Emami, Iman Salahshourifar, Thirumulu Ponnuraj Kannan, Arch Plast Surg, 2012, May; 39(3); 184-189.Published online 2012 May 10.
4. Betarbet, U., & Blalock, T. W. (2020). Keloids: a review of

etiology, prevention, and treatment. *The Journal of clinical and aesthetic dermatology, 13*(2), 33.
5. Andrews, J. P., Marttala, J., Macarak, E., Rosenbloom, J., & Uitto, J. (2016). Keloids: The paradigm of skin fibrosis—Pathomechanisms and treatment. *Matrix Biology, 51*, 37-46.
6. Berman, B., Maderal, A., & Raphael, B. (2017). Keloids and hypertrophic scars: pathophysiology, classification, and treatment. *Dermatologic Surgery, 43*, S3-S18.
7. Leong M, Murphy KD, Phillips LG. Wound healing. In: Townsend CM Jr., Beauchamp RD, Evers BM,Mattox KL, editors. Sabiston Textbook of Surgery. Philadelphia, PA: Elsevier; 2017. pp. 130–162.
8. Keloid scars: Diagnosis and treatment, American Academy of Dermatology Association, AAD 4.9.2023.
9. Jumper, N., Paus, R., & Bayat, A. (2015). Functional histopathology of keloid disease.
10. Wulandari, E., Jusman, S. W. A., Moenadjat, Y., Jusuf, A. A., & Sadikin, M. (2016). Expressions of collagen I and III in hypoxic keloid tissue. *The Kobe Journal of Medical Sciences, 62*(3), E58.
11. Launer, P. J., & Arkles, B. (1987). Infrared analysis of organosilicon compounds: spectra-structure correlations. *Silicone compounds register and review, 100,* 100-103.
12. Magni, G., Banchelli, M., Cherchi, F., Coppi, E., Fraccalvieri, M., Rossi, M., ... & Rossi, F. (2020). Experimental study on blue light interaction with human keloid-derived fibroblasts. *Biomedicines, 8*(12), 573.