The use of non-ablative long pulsed ND YAG laser (1064 nm) versus full concentration TCA in treatment of acne scars

A thesis
Submitted for fulfillment of Master Degree
In
Dermatology, Andrology and STDs

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Acknowledgments

First and foremost, my deepest praises are due to Almighty Allah the most merciful and gracious.

I would like to express my sincere gratitude to my dear supervisors,

Dr. Zeinab Abd El-Latif Shaheen, under the supervision of whom I had the privilege to work this thesis, for giving me the best encouragement, support and trust during the entire course of this thesis.

Dr. Shereen Osama Tawfiq, for her sincere help, valuable advice and encouragement, to get this work done appropriately.

Dr. Naglaa Mohammad Sameh Zaki, for being so generous and patient in teaching me, during the entire course of this thesis.

I want to express my deep appreciation to ***Dr. Mohammad Hussein Medhat El-Komy***, for his precious advice and valuable references he provided me with, during the course of this thesis.

I like to offer my deepest thanks to all staff members, my fellow residents and assistant lecturers in the dermatology department and in Students' Hospital for their support and cooperation.

Last but never least; I like to express my deepest and infinite gratitude to my mother for her devoted unconditional love and support during the entire course of this thesis.

Finally, this work is dedicated to the person who has affected my life the most, the one who taught me faith, self-dependence, and has always been the greatest inspiration to me. To the memory of my father.

ABSTRACT

Background: Facial acne scarring is treated with multiple procedures with varying degrees of improvement. Non-ablative rejuvenation with 1064 nm ND-YAG laser has been reported to provide significant improvement in treating atrophic acne scars. Full concentration TCA CROSS method has also been reported as an effective procedure for treating atrophic acne scarring.

Objective: To compare the efficacy of non-ablative 1064 nm Nd :YAG and full concentration TCA CROSS method as different therapeutic modalities in treatment of atrophic acne scarring.

Results: Both non-ablative 1064 nm Nd-YAG and full concentration TCA CROSS method are effective modalities in treating atrophic acne scars, both have comparably close results. However, non-ablative rejuvenation has much less side effects and minimal downtime.

Key words: acne scars, full concentration TCA CROSS, non-ablative, 1064 Nd-YAG

Table of contents

List of abbreviations

°C	degrees centigrade
AHA	alpha hydroxyl acid
CD	Cluster of Differentiation
cm	centimeter
CO_2	Carbon dioxide
CROSS	chemical reconstruction of skin scars
ECCA	e´chelle d'e´valuation clinique des cicatrices d'acne´
ECM	Extracellular matrix
Er: YAG	Erbium: yttrium-aluminum-garnet
FR	Fractional resurfacing
Gy	gray
HLA-DR	human leukocyte antigen (DR: a molecule of cell surface receptor and a marker for immune stimulation)
Hsp	heat shock proteins
Hz	Hertz
ICAM-1	intercellular adhesion molecule-1
IL	interleukin
IL-1β	Interleukin one beta
IPL	Intense pulsed light
J	Joule
KTP	Potassium titanyl phosphate
LED	Light-emitting diodes
MEND	Microscopic epidermal necrotic debris
mL	milliliter
mm	millimeter
MMPs	Matrix metalloproteinases
mRNA	messenger-Ribonucleic acid
MTZ	microthermal treatment zones
ND:YAG	neodymium: yttrium-aluminum-garnet
nm	nanometer
P. acnes	Propriobacterium acnes

PCR	Polymerase chain reaction
PDL	Pulsed dye laser
PDT	Photodynamic therapy
RECK	reversion-inducing cysteine-rich protein with Kazal motifs
RF	Radiofrequency
S aureus	Staphylococcus aureus
TCA	trichloroacetic acid
TGF-β1	transforming growth facto beta one
TIMPs	tissue inhibitors of metalloproteinases
TLR	Toll like receptor
TNF-α	Tumor necrosis factor alpha
TRT	thermal relaxation time
VCAM-1	vascular cell adhesion molecule-1

List of tables

List of figures

Introduction:

Acne lesions usually arise from the pilosebaceous follicles, which initially become obstructed with horny cells. Then a closed or opened comedo usually develops, which may later become inflamed. The presence of Propionibacterium acne is essential in the development of inflammatory acne. The follicular thinning of the wall may result in rupture of the hair follicle with stimulation of foreign body reaction and activation of the complement cascade. At this point, an attempt to limit the inflammatory reaction by epidermal encapsulation occurs. It is the degree of inflammation that determines the risk and amount of post-acne scarring. Acne scarring originates from a deep inflammatory reaction, and involves the destruction or loss of connective tissue, with dermal atrophy and fibrosis. During the maturation phase, the scar contracts and pulls the surface layers, causing indentation of the skin. Even though atrophic scars are the most common type of post-acne scarring, some patients may also present with hypertrophic scars and keloids ***(Choi et al., 2006).***

Acne scarring is common but surprisingly difficult to treat. Scars can involve textural change in the superficial and deep dermis, and can also be associated with erythema, and less often, pigmentary change. In general, treatment of acne scarring is a multistep procedure. It is important to emphasize to the patient that acne scarring can be improved but never entirely reversed ***(Alam and Dover , 2006).***

Acne scars may be atrophic or hypertrophic. The former type is usually classified as rolling, icepick or boxcar. Rolling scars are gently undulating appearing like hills or valleys without sharp borders while icepick (pitting) scars appear as round deep depressions culminating in

a pin point base. On the other hand, boxcar scars are larger in size with sharply defined edge and may be either shallow or deep. Shallow boxcar scars terminate in the superfacial to mid dermis while deep boxcar scars penetrate more deeply into the reticular dermis ***(Alam and Dover, 2006).***

Therapeutic intervention for post acne scarring has been limited by the considerable morbidity with only marginal efficacy. Within the last decade, however, better understanding of the pathogenesis of acne scarring has led to the development of techniques that offer more favorable risk/benefit profiles ***(Goodman and Baron, 2007).***

Currently available therapeutic alternatives include dermabrasion, microdermabrasion, ablative lasers, non ablative lasers, fat transplantation, dermal fillers, autologous local blood injection, subcision, punch excision, punch excision with skin graft replacement, punch elevation and chemical peeling ***(Sadick and schecter, 2004 & Goodman and Baron, 2007).***

Non ablative laser is a new method that uses medical grade laser to stimulate collagen growth, reduce pigmentation and improve the skin texture. It works mainly by thermally stimulating dermal collagen remodeling, so softening acne scars in a minimally invasive fashion. It generates dermal heat through vasculture and melanin containing structures such as the hair follicle. How non ablative laser works remains the subject of active research but photothermal (or electrothermal) injury is likely the major stimulus. Sublethal heating of the vascular endothelium and fibroblast is thought to initiate a cascade of dermal remodeling through induction of cytokines (e.g platelets derived growth factor) and enzymes (collagenase) involved in the

normal wound healing process. 1064 nm Nd:YAG laser produces gradual dermal heating through cumulative absorption by oxyhaemoglobin within the normal dermal microvasculture. The temporal and energy profile of this laser facilitates diffusion of heat from the dermal microvasculture into the surrounding papillary and reticular dermis without inducing purpura or epidermal injury ***(Lipper and Perez ,2006 & Rogachefsky et al., 2003).***

Medium-depth chemical peels can cause regeneration of the epidermis and dermis, resulting in an increase in collagen, elastin and glycosaminoglycans. Dermal collagen remodelling continues to occur for several months ***(Brody, 1989; Cho et al., 2006).***

High-concentration TCA (95–100%) applied focally to atrophic acne scars, has been histologically shown to increase collagen fibres in the dermis and to result in decreased depth of acne scars. ***(Yug et al., 2006).*** This is also called the 'chemical reconstruction of skin scars' (CROSS method) ***(Lee et al., 2002)***, in which high-concentration TCA application has been shown to induce epidermal and dermal rejuvenation by stimulating deposition of collagen ***(Cho et al., 2006).***

Although acne scars are recalcitrant to many therapeutic interventions, several therapeutic modalities either alone or in combination had to be studied for treatment of acne scars. A combination of treatments is often required to achieve satisfactory results ***(Jacob et al., 2001).***

Aim of work: This study was designed to compare the efficacy of non ablative Nd:YAG laser and high concentrated TCA CROSS method as different therapeutic modalities for the treatment of atrophic acne scars.

Acne vulgaris

Definition:

Acne is a disease of the pilosebaceous units, clinically characterized by seborrhea, comedones, papules, pustules, nodules and, in some cases, scarring ***(Simpson and Cunliffe, 2004).***

Prevalence:

Acne is a very common disease. Its prevalence is about 58% of women and 40% of men, 95–100% of 16–17-year-old males and 83–85% of 16–17-year-old females. The prevalence of clinical acne decreased significantly only after age 45 years as the vast majority of cases are below 23–25 years of age but 1% of males and 5% of females exhibit acne lesions at 40 years of age ***(Goodman., 2001 a)*** and ***(Rivera, 2008)***.

Updates in etiopathogenesis of acne:

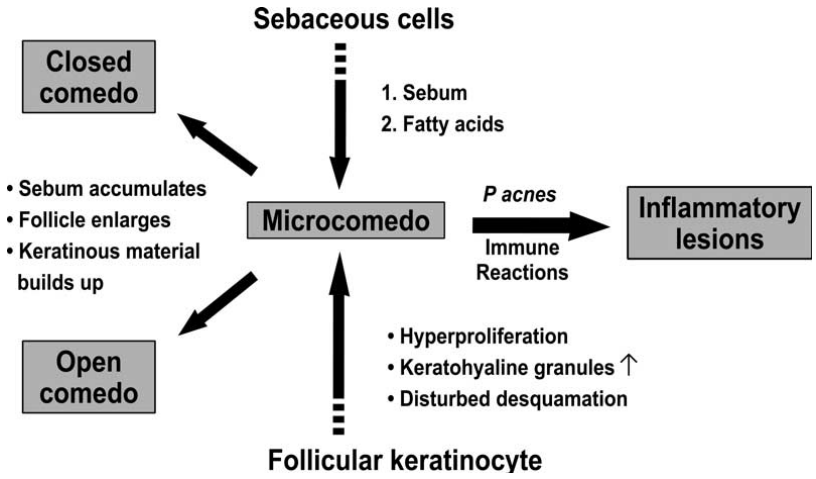

Fig 1. Lesion progression in acne.

Acne is caused and characterized by multiple factors, including: propionibacterium acnes activity; increased sebum production; androgenic stimulation; follicular hypercornification;lymphocyte,

macrophage, and neutrophil inflammatory response and cytokine activation ***(Rivera, 2008)***.

Recently, cellular culture studies have provided more information about the role of sebaceous lipids and inflammatory mediators including matrix metalloproteinases MMPs ***(Thiboutot et al., 2009).***

In ***2003 Jeremy et al***., investigated the initiating events for acne lesions, and found that immune changes and inflammatory responses occur **before** hyperproliferation of keratinocytes, with a pattern similar to a type IV delayed hypersensitivity response. The immune response is led by CD41 lymphocytes and macrophages. These researchers hypothesize that the subsequent production of cytokines activates local endothelial cells, up-regulating inflammatory vascular markers (E-selectin, vascular cell adhesion molecule-1 [VCAM-1], intercellular adhesion molecule-1 [ICAM-1], and human leukocyte antigen- DR [HLA-DR]) in the vasculature around the pilosebaceous follicle. They further have postulated that the entire process is initiated by interleukin (IL)-1α up-regulation, in response to a relative linoleic acid deficiency, caused by excess sebum and perturbation of barrier function within the follicle ***(Jeremy et al., 2003)***.

Factors that have been linked to a chronic course include stress-related production of adrenal androgens, propionibacterium acnes colonization, familial background, and specific subtypes of acne (conglobata, keloidal, inversa, androgenic, scalp folliculitis, and chloracne) ***(Thiboutot et al., 2009).***

A soluble factor of P. acnes induces the synthesis of tumor necrosis factor-α and IL-1β in the cell lines through activation of toll like receptor 2 (TLR-2) ***(Kim et. al., 2002).***

Patho-physiology of acne scarring:

Scarring occurs early in acne and may affect about 95% of patients with this disease and relates to both its severity and delay before treatment. All types of acne will scar and adequate treatment must be started early ***(Rivera, 2008)***.

Acne scarring is a consequence of abnormal resolution or wound healing after the damage that occurs in the sebaceous follicle during acne inflammation. Cell-mediated immune responses not only contribute to the clearances of antigen but also to tissue damage. Therefore, the type of immune response of patients predisposed to scar may be different to those who do not scar ***(Holland and Jeremy, 2005)***.

In early lesions (of 6 to 48 hours), the numbers of macrophages, blood vessels and vascular adhesion molecules were high and comparable in both sets of patients, while the numbers of Langerhans cells and the level of cellular activation were low in lesions from scarrers, indicative of an ineffective response to the causal antigen(s). However, in resolving lesions from scarrers there was an upregulation of the response with greater cellular activation and a further influx of macrophages and skin homing memory/effector cells ***(Holland and Jeremy, 2005)***.

Injury to the skin initiates a cascade of wound healing events, which progresses through 3 stages: inflammation, granulation tissue formation, and matrix remodeling. Numerous cells, growth factors, cytokines, and components of the extracellular matrix (mainly MMPs and inhibitors of MMPs) are involved in the process ***(Alster and Zaulyanov, 2007).***

The **first step** in wound healing is coagulation and inflammation. Blanching occurs secondary to vasoconstriction for hemostasis.

Melanogenesis may also be stimulated. This step has an important role in the development of postacne erythema and hyperpigmentation ***(Baum et al., 2005*** and ***Nouri et al., 2009).***

In the **second step**, new production of collagen by fibroblasts begins approximately three to five days after the wound is created. However, the balance of collagen types shifts in mature scars to be similar to that of unwounded skin. Keratinocytes proliferate and migrate to the site, closing the wound and eliminating the fibrin clot ***(Nouri et al., 2009)***

In the **third step**, which has a long duration (weeks or months), fibroblasts and keratinocytes produce enzymes including those that determine the architecture of the extracellular MMPs and tissue inhibitors of MMPs. An imbalance in the ratio of MMPs to tissue inhibitors of MMPs results in the development of atrophic or hypertrophic scars. These agents may thus shift the balance of MMP: tissue inhibitors of MMP back toward normal and reduce the likelihood of scar development ***(Kang et al., 2005)***.

When the healing response is too exuberant, a raised fibrotic nodule forms; inadequate response results in diminished deposition of collagen factors and formation of an atrophic scar. Pigmentary and vascular changes caused by acne are often temporary; however, changes in texture caused by disruption of collagen are often permanent ***(Nouri et al., 2009)***.

The fact that *P. acnes* is not readily susceptible to phagocytosis and can persist intracellularly within macrophages for prolonged periods must be of relevance ***(Webster et al., 1985).*** Inflammatory response has been implicated as an important component in the development of scars ***(Cowin et al., 1998).***