

Effect of Pressure on Hypertrophic Scars and Keloid in A Clinico Pathological Study

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ABSTRACT

Keloids remain a problem for surgeons. Topical and intralesional corticosteroids, positive pressure dressings, cryotherapy, and laser therapy are helpful but not uniformly successful. The objective of the present study was to document the effectiveness of mechanical pressure therapy as one of the physical therapy modalities, in the form of silicone gel sheeting in the reduction of evolving keloids. Silicone gel pressure was placed over evolving scars in 20 cases. pressure was used for at least 12 hours a day. Biopsies were examined for presence of silica in the tissue. The results showed that the lesions were significantly improved after the treatment period in all of the cases. The mechanisms of action are unknown. The present study concluded that daily treatment with pressure silicone gel sheeting should begin as soon as an itchy red streak develops in a keloid. The pressure is effective in reducing the bulk of these lesions.

INTRODUCTION

A hypertrophic scar is an overgrowth of dermal constituents that remains within the boundaries of the wound. A keloid is a scar that extends beyond the boundaries of the original wound²⁹.

Trauma of various origins can induce a connective tissue disorder that leads to keloids. This condition has yet not been clearly distinguished from scars and hypertrophic scars. Only electronmicroscopic and biochemical data can help to do this. Among some more or less therapeutic approaches, the use of silicon (polydime-thylsiloxane) plates as mechanical pressure, wrapped on the keloid

surface, has been reported effective by some authors^{26,25}.

According to Fulton¹⁰, keloid remain a problem for surgeons. Topical and intralesional corticosteroids, physical therapy modalities including positive pressure dressings, cryotherapy, and laser therapy are helpful but not uniformly successful^{26,10}.

Murray²⁵, proposed that despite the disfigurement and symptoms from these abnormal wound responses, the literature offers little consensus about appropriate therapy. Few prospective blinded studies have been performed to compare therapeutic options.

Historically, Fujimori et al.,⁹ used a technique of sponge fixation to control

scarring after skin grafting procedures. Subsequently, the practice of utilizing pressure therapy for burn scar control became a widely accepted intervention.

According to Leung et al.,²⁰ and Esposito et al.,⁶ the geometry of the body surface influences the amount of compression applied by pressure garments and is governed by Laplace's law. Laplace's law is defined as: Pressure = Tension / Radius of curvature.

Many researchers have stated that approximately 25 mm Hg capillary pressure is necessary to produce changes in scar tissue, but this value has not been proven absolute.⁸ Scars treated with pressure greater than 15 mm Hg have been noted to be flatter, smoother, and less erythematous than scars treated with lower pressure¹². However, accelerated remodeling may occur with pressures less than 10 mm Hg. At pressures greater than 40 mm Hg maceration and paresthesia may occur³⁰. Artell and colleagues³ used a special air-flow measuring manometer to measure garment-scar interface pressure on patients. They found a wide variation of pressures over different parts of the body. These differences were due in part to the compliance of the tissue underlying the scar and in part to the geometry of the area^{4,24,7}.

Ahn et al.^{1,2} and Ward³⁴ stated that the silicone is a term relating to a family of polymers based on the element silicon. The polymers range in viscosity from fluid through gel and solid states. Silicone gel pads, which are inert, clear, and flexible, have been used as a pressure therapy in Australia, Europe, and the United States since the early 1980s and have become increasingly popular over the past several years^{27,2}.

Reported benefits of silicone gel pressure pads include increased range of motion, minimizing pain, preventing shrinkage of skin

grafts, minimizing hypertrophic scarring, assisting with softening and smoothing of scars, and increasing pressure over movable areas where pressure is difficult to maintain^{27,35,5}.

Hag and Hag¹⁴ reported that pressure therapy obviated the need for repetitive surgery and no recurrence was noted. This methods are advocated as an adjunct measure for all cases of hypertrophic scarring, burn contracture and keloid⁵.

The aim of the study was to investigate the effectiveness of silicone gel pressure in the reduction of evolving keloids.

MATERIAL AND METHODS

Subjects:

Twenty volunteered subjects (13 females and 7 male) of an age ranging between 25 and 35 years were studied pre & post treatment.

They were investigated before treatment and after one month, from pressure therapy application, using CAS 200 Image Analyzer (Beton Dickinson, Cell Analysis Systems, Inc., Elmhurst, IL, U.S.A.) in Department of Pathology, Al-Azhar University, Faculty of Medicine. This high technology analyzer detect the average width of collagen bundles (50 bundle for each case). This technique was done after excision of a bioposy from a patient's keloid, and prepare it for investigations.

Procedure

Pressure garments (Silicone gel sheeting) were applied over the keloid and hypertrophic scars for all the patients. Pressure therapy might be constant, such that pressure was maintained 22 to 23 hours a day⁷. Pressure dressings were removed only for personal hygiene, moistureizing the skin, and stretching exercises. However, this relief period should

not exceed 30 to 60 minutes at any one time^{31,13,28}. Pressure garments were fit snugly (unable to easily pinch fabric away from body part), but not so tight that circulation is compromised or marks from seams remain indented on the skin for longer than 30 minutes after the garment was removed. Custom-made pressure garments were approximately 60 percent porous; therefore, a sunscreen was used in conjunction with them if a patient would be out in the sun for any period of time. The pressure garments used were a combination of nylon and spandex material that is compatible with all moisturizing creams. However, vitamin E oil might be absorbed into the garment and degrade the spandex. Regardless of type, the cream was completely washed out of the garment. Changing of garments was done every 12 hours and careful cleaning of the garments were applied to ensure that body oil and creams had been removed to prolong the life of the garments.

RESULTS

Table (1) and Fig. (1) show the width of collagen bundles before and after pressure therapy. Before treatment the width ranged from 8.42 - 16.35, with a mean value of $12.02 \pm 2.45 \mu$. After pressure, the width ranged from 3.14 - 10.18, with a mean value of $6.48 \pm 1.82 \mu$. The difference between the values before and after exercise were significant ($t_{\text{paired}} = 14.4108$, $P < 0.001$). The mean difference was 5.54μ (46.09 %).

Table (1) : Width of collagen bundles before and after pressure therapy.

| No. | Before Pressure (μ) | After Pressure (μ) |
|-----------|------------------------------|-----------------------------|
| 1 | 10.33 | 5.1 |
| 2 | 9.12 | 7.28 |
| 3 | 11.24 | 6.12 |
| 4 | 14.38 | 8.17 |
| 5 | 12.26 | 7.42 |
| 6 | 13.11 | 7.12 |
| 7 | 13.58 | 6.10 |
| 8 | 9.18 | 6.01 |
| 9 | 12.33 | 8.17 |
| 10 | 14.62 | 9.45 |
| 11 | 9.18 | 5.20 |
| 12 | 10.66 | 6.79 |
| 13 | 12.95 | 6.07 |
| 14 | 16.35 | 7.5 |
| 15 | 8.42 | 3.14 |
| 16 | 15.57 | 10.18 |
| 17 | 14.42 | 6.15 |
| 18 | 8.93 | 3.28 |
| 19 | 13.78 | 6.25 |
| 20 | 9.89 | 4.06 |
| Mean | 12.02 | 6.48 |
| \pm S.D | 2.45 | 1.82 |
| t paired | | 14.4108 |
| P | | <0.001 |

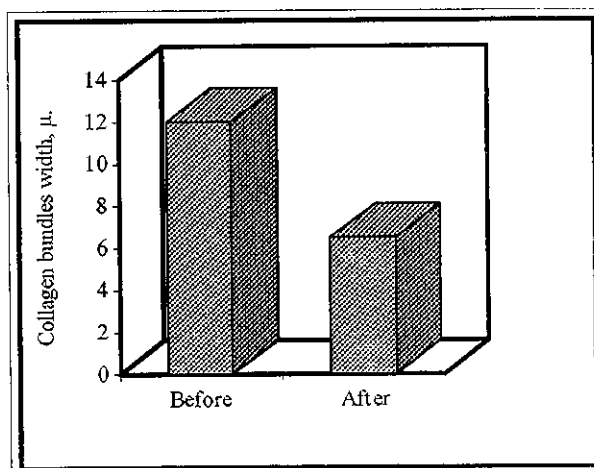
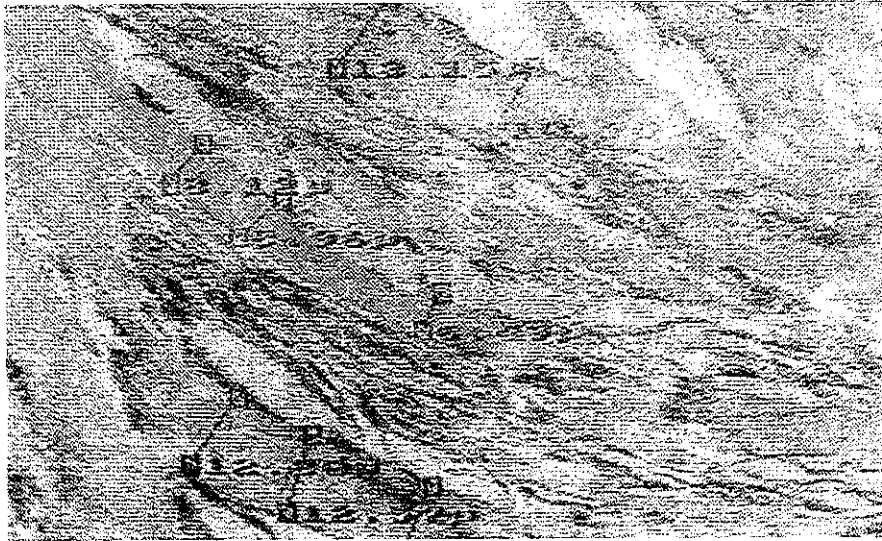
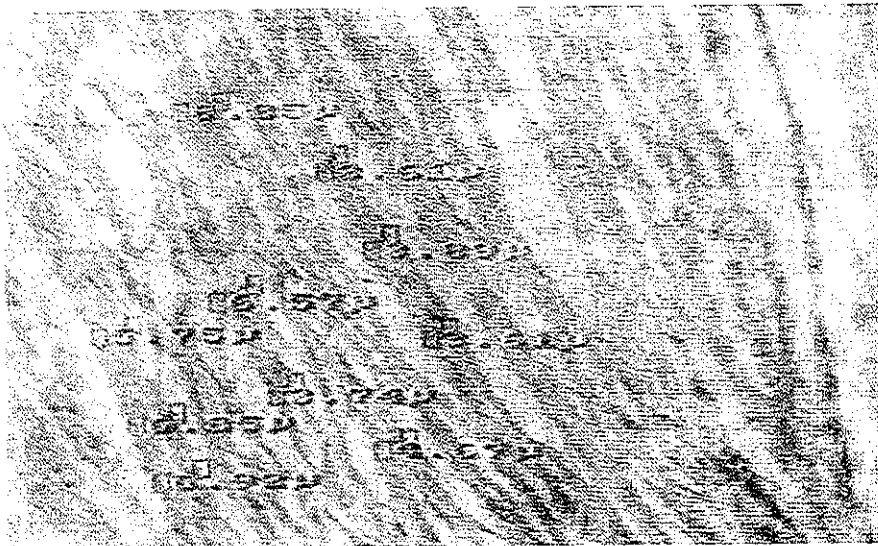


Fig. (1): Mean width of collagen bundles before and after pressure therapy.



(A) Before treatment.



(B) After treatment.

Fig. (2): Shows the difference of collagen bundles width before & after application of pressure therapy in the 1st case, in which before treatment the average width was 10.33 micron and after pressure it decreased to 5.1 micron.

DISCUSSION

Despite the fact that no study confirms the mechanism by which pressure alters the structure of scar^{29,23}, pressure has been noted to have a thinning effect on the dermis^{14,5}. Mechanical compression of a scar causes a visible blanching that indicates decreased blood flow through the scar^{34,2,10}.

This decreased flow leads to tissue hypoxia with a resultant reduction in cell proliferation^{25,34}. Due to decreased blood flow, the number of collagenase inhibitors decrease and the rate of collagen lysis is enhanced. The overall effect of applying pressure is an improved balance between collagen synthesis and lysis of a scar^{16,18}.

Fulton¹⁰, and Palmieri et al.²⁶ proposed that compression of scar tissue produces the following: reduction in tissue edema with less ground substance production, scar nodules disappear, collagen bundles are reoriented parallel to the epidermal surface, and large bundles of collagen fibers convert to smaller groups of fibers arranged in a less compact fashion, (Table 2).

According to Sullivan³² and Kealey et al.¹⁵, pressure therapy which is considered as one of the physical therapy modalities appears to accelerate the scar maturation process by inducing changes in the physical properties of scar tissue in a period of months rather than years^{19,22}.

Rockwell et al.³¹, and Clarke et al.⁴ and Keehnen et al.¹⁶, suggested that under such treatment, fibroblasts, pericytes and endothelial cells degenerate, probably at a rate greater than that which occurs normally. As degeneration of apoptosis continues the nodules and scar become more avascular and more hypoxic, prompting fibroblast death and

release of lysosomal enzymes important for maturation^{11,17,21}.

Table (2): Hypothetical Effects of Pressure Therapy on Burn Scar (Coated From Fulton¹⁰)

- Accelerates the scar maturation process.
- Superficial blanching
- Flattening of the scar
- Increased pliability.
- Decreased blood flow.
- Decreased edema
- Decreased rate of collagen synthesis.
- Collagen bundles realign parallel to epidermal surface.
- Absent or less prominent nodules.
- Decreased cohesiveness of intercollagen fibers.
- Increased collagenase-mediated collagen breakdown
- Gradual decrease in myofibroblasts.
- Stabilization and gradual decrease in mast cells
- Decreased deposition and change in ground substance.
- Thinning of dermis.

SUMMARY

Keloid remain a problem for surgeons. This study was conducted to investigate the effectiveness of silicone gel pressure in the reduction of evolving keloids. Twenty volunteered subjects of an age ranging between 25 and 35 years were studied pre and post treatment using CAS 200 Image Analyzer. The pressure garments were applied over the keloid and hypertrophic scars for one month (22-23 hours a day). The results of the study showed that before treatment, the width ranged between 8.42 - 16.35, with a mean value of $12.02 \pm 2.45 \mu$. After pressure, the width ranged between 3.14 - 10.18, with a mean value of $6.48 \pm 1.82 \mu$. The difference between the values before and after pressure were significant (t paired = 14.4108, $P < 0.001$). The mean difference was 5.54μ (46.09%).

CONCLUSION

Daily treatments with pressure therapy using silicone gel sheeting should begin as soon as an itchy red streak develops in a keloid. The pressure treatment is effective in reducing the bulk of these lesions.

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المختصر العربي

تأثير الضغط على الندبات المرتفعة والكيلويد دراسة إكلينيكية وباثولوجية

يشكل الكيلويد مشكلة للجراحين. شملت الدراسة الحالية عشرين متطوعاً من الجنسين. وكان هدف الدراسة تحديد تأثير العلاج بالضغط كوسيلة من وسائل العلاج الطبيعي على الندبات المرتفعة، تم عمل القياس التقريبي لعرض الحزمة المأخوذة من عينة الكيلويد والندبات المرتفعة باستخدام جهاز تحليل الخلايا بكلية طب الأزهر. وقد أثبتت النتائج أن متوسط الحزمة قبل العلاج ٨,٤٢ - ١٦,٣٥ مايكرون بمتوسط $12,2 \pm$ إلى ٢,٤٥ وبعد العلاج ١٠,١٨ - ٣,١٤ بمتوسط $1,82 \pm 6,68$ وأن الفرق بين النتائج بعد العلاج كانت إيجابية ومتوسط الفرق ٥,٥٤ مايكرون (٤٦,٠٩%).