Role of Pressure Garment Therapy Burn Scars

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Abstract

Burns scarring is the major problem who recovers from burn injury. Hypertrophic scars can severely impair the degree of function, including job and day to day activities. The use of pressure garment therapy (PGT) is a common method of preventing and treating hypertrophic scarring which is followed worldwide. In this study, we aim to compile and evaluate research on PGT's effectiveness in treating post-burn hypertrophic scars.

Keywords: Pressure garment therapy; Burns; Scar.

INTRODUCTION

Hypertrophic scarring can be thought of as a systemic inflammatory illness that is controlled by local factors that help the wound heal. Patients and healthcare professionals still face difficult challenges with hypertrophic burn scars, which are a common issue for burn survivors who have undergone skin grafting or delayed healing.[1] They can severely restrict a burn survivor's level of function, including their ability to engage in job or leisure activities, and are frequently a source of morbidity that presents with lifestyle restricting issues like pruritus, pain, burning, stiffness, and even contractures. One of the most crucial aspects of burn therapy is the prevention and treatment of hypertrophic scars. Early and aggressive treatment is essential for their optimal management. Wearing clothing composed of elasticized textiles is one of the pressure therapy alternatives for treating hypertrophic burn scars. It has a strong foundation in the literature and is applied widely throughout the world.[2] Due to its non-invasive qualities, expected good therapeutic results, and minimal related problems, PGT is currently the conventional first line therapy for hypertrophic burn scars in many facilities.

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MATERIALS AND METHODS

This study was conducted in the Department of Plastic Surgery in a tertiary care institute. Department scientific committee approval was obtained. It is a review article based on studies from the literatures available in Scopus, Cochrane and PubMed. It summarizes the usefulness and its limitations of Pressure garment therapy in the treatment and prevention of post burn scarring.

DISCUSSION

In this review article, we are discussing about the role of pressure garment therapy in post burn hypertrophic scars under the following headings.

Background and History

In 1962, Mancini and Quaife made the difference between keloid and hypertrophic scarring the way we know it today. In 1973, Madden and Peacock gave the first explanation of keloid and hypertrophic scarring from a histological point of view. Ambroise Paré, a French barber surgeon who was a pioneer in battlefield medicine, wrote about pressure therapy for scars in the 1600s. Paré said that scars could be made better by putting pressure on them with a lead plate that has been rubbed against mercury. Not until the middle of the 20th century were people first given elasticized, form fitting clothes to help with surgical scars on the neck. In 1960, Fujumori et al. wrote about what happened when they put an adhesive foam mould on hypertrophic scars on the neck. Cronin and Gottlieb both said that they used cervical splints after contractures in the neck were released and reconstruction was done with split thickness skin grafts. Pressure therapy for hypertrophic burn scars was first popularized at the Shriners Galveston Burn Hospital.[1] Shriners Hospitals for Children's chief of staff, Dr. Duane Larson, and his team were the first to use the modern elasticized, custom made pressure garment for burns. In the late 1960s and early 1970s, several publications from their centre spread the word about the technique in the United States and Canada, and then around the world.

Designing the Pressure Garment

The pressure garments are expensive for the burn patients or health care units to purchase, to provide more effective pressure therapy. It is essential that the best possible product is supplied to patients in terms of better fit, fewer alterations, less likelihood of stretching, and component parts that are less likely to cause discomfort or deterioration. Fabricating a compression garment with a required pressure is important. Pressure exerted by a garment is largely determined by the fabric tension per unit length. It is also influenced by the number of fabric layers used for its construction as well as by fabric grain direction that must be aligned with the stretching direction.[2]

CLASSIFICATION OF PRESSURE GARMENTS

There are 2 methods of Constructing Pressure Garments

- The Reduction Factor method is the most commonly used method; it involves reducing the patient's circum ferential measurements by a certain percentage without taking into account the fabric tension when calculating garment dimensions. After the circumferential dimensions of a wounded body part are obtained with a measuring tape, pressure garments are normally fabricated based on a standard 'reduction factor' of 10, 15 or 20% applied to the patient's measurements. The reduction factor used is constant and is not normally changed based on the dimensions of the body part being treated or the specific properties of the fabric.
- The second method uses the Laplace's Law 3 based on the circumferential measurements of the patient and the tension profile of the fabric.

The garments are cut and fabricated from elastic fabrics, typically powernet or sleeknit warp knitted fabrics made from nylon and elastane filaments. The more frequent and accurate the measurements, the better the garment is likely to fit the patient. Since, no body part is a uniform, pressure exerted by a garment with a given tension is not uniform and is distributed differently over the various areas of the body for any given patient. Clearly concave areas of the body do not make contact with the pressure garment and therefore no pressure is exerted on them.

Manufacturers of pressure garments for burn patients report that custom pressure garments provide 25 mmHg of pressure. The pressure garments lose tension and therefore pressure-delivering ability over time and use. Fit must be monitored regularly and carefully as the garments lose about 50% of their compression in 1 month. It is interesting to note also that pressure garments designed to exert greater pressures degrade faster than those designed to exert lower pressures.

The contact between pressure garments and moisturizers accelerates tension degradation. Machine washing on the other hand tends to prolong their pressure delivering properties compared with hand washing. To maintain adequate pressure, it is recommended that the garments be replaced every

2 to 3 months.[3] Despite precise fitting techniques, pressure garments do not provide a consistent amount of pressure at the scar/garment interface. Pressure garments exert compressive forces normal to the scar and also parallel to the surface of the scar. These forces act to oppose the direction of contracture.

MECHANISM OF ACTION

Compression is reported to produce regression of hypertrophic scars in 60 to 85 percent of patients. When a compressive force was applied to incisional wounds in an opposite direction to the wound tension, it was shown that scars did not form. These data suggest that the mechanical forces applied to the scar can assist in reducing differentiation of fibroblasts to myofibroblast, ultimately decreasing scar contraction and collagen deposition. It is likely that the reduced scar contraction observed in the current study was, in part, a result of reducing the strain state within the scar, which subsequently abates myofibroblast differentiation and excessive collagen deposition.[4]

The pressure garment therapy compared with controls, with a 34 percent increase in ultimate tensile strength. The pressure garment therapy produces altered collagen deposition in the dermis, composed of more densely packed collagen fibres. Human scars treated with pressure via elastic bandages resulted in thinner reticular collagen fibres that resemble those of normal skin. The theory behind the use of pressure garments relying on two main concepts; firstly, the restriction of blood flow to the scar area and secondly, constant compression to inhibit the growth of hypertrophic scar tissue. It is widely believed that pressure may facilitates car maturation and control collagen synthesis by limiting blood supply, oxygen, and nutrients as evidenced by reduced scar redness and oedema and by blanching used traditionally as an indicator of adequate pressure application.[4] Pressure has been postulated also to reduce collagen production to levels found in normal scar tissue more rapidly than what can be expected with the natural maturation process. Mechanical loading induces alteration in collagenfiber turnover, remodelling, and realignment and reduces development of whorled collagen nodules resulting in thinning and softening of scar tissues. The threshold of effective daily application period for pressure therapy depends on the longer application periods.

CELLULAR LEVEL MECHANISM

Compression induced tissue ischemia lowers tissue metabolism and boosts collagenase activity by blocking macroglobulin. Furthermore, local hypoxia leads to collagen degeneration, decreases cohesion between collagen fibres, and diminishes the total amount of chondroitin-4-sulfate. Additionally, as a result of pressure, the scar's hydration decreases, stabilising mast cells and reducing extracellular matrix and neovascularization. It quickens the post-burn reparative process' remission stage. Epylisin, tumour necrosis factor, and IL-1 are modulated by mechanical loading. Pressure significantly reduces the production of TGF-1 and the growth of scar cells. As a result, there is a net decrease in the deposition of collagen fibres because this inhibits fibroblast activity and multiplication. Experimental studies have demonstrated that the growth of cultured fibroblasts and TGF-β1 secretion are significantly decreased under a pressure system of at least 20 mmHg for 18 hours and cell doubling time is significantly decreased under pressure of 20 mmHg for 24 hours. The significant increase in PGE2 release caused by mechanical compression also raises the possibility that PGE2 plays a part in the pressure therapy-induced remission of hypertrophy. Additionally, the observed modulation of IL-1 and TNF release by mechanical loading may be a significant factor in the regression of hypertrophy brought on by elastic compression. There is growing evidence that the cellular scar components may also be directly impacted by pressure. Cellular mechano transduction is the process by which fibroblasts and keratinocytes respond to mechanical forces with signal transduction.[5]

In order to change cellular function or trigger apoptosis, perceived stimuli are translated into intracellular biochemical and gene expression signalling pathways. For none excitable cells such as fibroblasts, mechanical stimulation can be converted directly into chemical signalling that increases fibroblast fibrotic gene expression and greatly increases cellular apoptosis. It has been recently suggested that cellular adhesions, which normally serve as mechanoreceptors, may play also a crucial role in scar modulation following PGT. It is likely that an increase in extracellular matrix rigidity produced by compression garments leads to a higher level of mechanoreceptor activity and increased cellular apoptosis. Increased rigidity has also been shown to affect migration, proliferation, and differentiation of cells in vitro. Increased rigidity caused by compression may

as well alter or inhibit the differentiation and proliferation of scar fibroblasts in vivo.[5] Moreover, as an adjunctive function, pressure garments that isolate and decrease the tension on the scar for a prolonged period may decrease the activity of mechano sensitive nociceptors and thereby decrease neuropeptide release responsible for pain and itching sensations.

PATIENT COMPLIANCE TO PRESSURE GARMENTS

Pressure garment therapy requires significant sustained patient involvement and co-operation. Long-term patient compliance is an important factor for the effectiveness of pressure therapy.

Patient compliance with the recommended wearing schedule is difficult for many reasons to many patients.[6] Wearing pressure garments is uncomfortable and challenging; problems with movement, appearance, fit, comfort, swelling of extremities, rashes and blistering are Common. Moreover, quality of the garments and a rapid general wear and tear are important contributing factors to low compliance. Patients are unlikely to wear pressure garments that do not fit well. It is reported that only 60% of pressure garments fit perfectly the first time and 40%require adjustments. Reported compliance for head and neck pressure garments is only 44%, and patients usually apply the garments no more than 10 to 14 hours of the prescribed 23 hours a day. Moreover, social support and a good doctor patient relationship are important supportive factors that help patients to per severe with their therapy.[6]

APPLICATION OF PRESSURE GARMENTS

Prophylactic pressure therapy is generally recommended in burn patients requiring burn wound excision and grafting or in wounds taking longer than 10-14 days for spontaneous closure. It is recommended that pressure should be maintained between 20 and 30 mmHg, which is above capillary pressure but less than what would diminish peripheral blood circulation. To be effective, PGT should be maintained for at least 6 to 12 months.[7] Patients are instructed to wear pressure garments 23 hours each day, and better results are observed if PGT is initiated prophylactically as early as 2 weeks following wound closure.[7] As far as patient preferences, most feel that pressure garments contributed positively to mobility as well as to the look and feel of scars even though they do not feel comfortable wearing the pressure garments and face masks outside of their home.

Disadvantages

Pressure garment monitoring is complex, time-consuming and not routine. Unknown is the ideal PGT pressure. Even though pressure dose seems to be a component in scar reduction, it's difficult to evaluate pressure therapy and achieve the optimum treatment results without knowing the pressure level. In most reported investigations, failure to document pressure magnitude with an accurate and reliable pressure monitoring tool may have led to variable treatment outcomes and inconsistent PGT therapeutic efficacy. The pressure garments are unattractive and are associated with high costs and potential patient morbidity. The PGT has been reported to cause overheating, pruritus, blistering, wound breakdown, and abnormal bone growth. The pressure garments are highly uncomfortable in hot and humid climates.[6,8] Ninety five percent of respondents reported functional or physical problems in using the pressure garment, in the form of sweating, overheating, pain or itch, and 67% reported that additional effort is needed to manage the garment.[9]

Recent advances

The treatment of hypertrophic scars is multimodality at present, along with pressure garment, scar massage, silicone gel sheet, Er-yag laser scar resurfacing, Low level laser therapy, vitamin E, Onion extract can also be used for the better results. Recent research suggests that pressure garment therapy can prevent and/or treat aberrant scarring following burn injury, but only in moderate or severe cases.[10]

CONCLUSION

Pressure garments can improve function and cosmesis along with effective exercise, splinting, positioning, and reconstructive surgery. Pressure garment therapy is the usual treatment for burn scars. Factors that limit the effectiveness of pressure therapy in the prevention of hypertrophic scars are limited patient compliance and the need to frequently procure new garments, as garments lose elasticity after 6 to 8 weeks. A pressure of at least 24 mmHg and almost complete compliance are needed to achieve significant scar improvement with pressure garments after burns. Pressure garments may be effective at reducing the thickness of hypertrophic scars but require high levels of patient compliance. Although this therapy has

been utilized for years, its efficacy is disputed. Lack of a pressure measurement equipment that can reliably measure low interface pressures prevents normal assessment of pressure garment pressures. Optimal pressure for hypertrophic scar resolution has not been determined.

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