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The Effectiveness of Tubi Grip vs. Pressure Garments in the Rehabilitation Program of Post-Burn Hypertrophic Scar.

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Thesis Approval

The Effectiveness of Tubi Grip vs. Pressure Garments in the Rehabilitation Program of Post-Burn Hypertrophic Scar

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Dedication

First and foremost, I would like to dedicate this project to God; for giving me strength, power of the mind, determination, and a healthy life.

This study is dedicated to my beloved family, who have given me strength when I felt tired and overwhelmed. They continuously provided me with their moral and emotional support.

For my wife I also write, she was the source of inspiration and motivation for me throughout my entire academic journey, always by my side sharing her love and compassion for me to push forward.

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This thesis is especially dedicated to Dr. Akram Amro, who encouraged and helped me stay motivated throughout the completion of my thesis. Thanks to the Al-Quds University family, and lecturers for always inspiring me to excel and grow as a researcher.

Declaration

This thesis is submitted in partial fulfillment of the requirement for the Master's degree in Physiotherapy.

I declare that the content of this thesis (or any part of the same) has not been submitted for a higher degree to any other University or institution.

Signed 

Mohanad Mohammed Saleh Mansoor

Date: 15/08/2022.

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I would like to express my gratitude to God for guiding me towards the successful completion of my thesis. The overall experience of my master's journey has been the most challenging pursuit of my life, yet a great privilege to attend the Faculty of Health Professions at Al-Quds University. In addition, I want to express my deepest gratitude to my supervisor Dr. Akram Amro, whose expertise and feedback paved the way for the completion of this research. He has been a wonderful mentor. I thank him for his patience, inspiration, and constant guidance.

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The Effectiveness of Tubi Grip vs. Pressure Garments in the Rehabilitation Program of Post-Burn Hypertrophic Scar.

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Abstract

Background: Hypertrophic scarring may occur after traumatic injury, surgical procedures, and most post burns. There is potentially a higher risk of emotional problems and functional restrictions. It is of great concern to patients and present a major challenge to plastic surgeons. Some of the management methods for example scar massage and silicone sheet bring beneficial outcomes and help avoid surgical intervention, Tubi grip, and pressure garments are the mainstay and the gold standard therapeutic methods for post-burn hypertrophic scar reduction. *The aim of this study is: - To evaluate the therapeutic efficiency of Tubi grip versus pressure garments on the characteristics of hypertrophic scar post burned patients.*

Methods: A randomized controlled trial design was used in this study. Measure ultrasonography was the main outcome measure used, in addition to the modified Vancouver Scar Scale. Thirty-patients were randomly recruited using the g systematic sampling method for this study. They were then randomly further divided into either experimental, or control groups. Inclusion criteria was included that participants in both groups should be between 6-18 years, who have upper or lower limb hypertrophic scar post-burns, and were receiving treatment in the Physiotherapy Department at Rafedia Governmental Hospital. The experimental group who received a Tubi grip in addition to the regular management program of friction massage, splinting, silicone gel, exercise and lubrication (moisturizing cream). The Control group received pressure garments in addition to regular management as stated above. The study was conducted from March to October 2021.

Results: A statistically significant difference was found between the pre and post-tests observed in the experimental group with the improvement in the US (M= 1.04, SD=.892), and the improvement in MVSS (M= 1.20, SD= .96) ($p \leq 0.05$). In addition, there was a statistically significant difference in the control group pre and post-tests. The improvement in the US (M= .863, SD=1.189), and the improvement in MVSS (M= .96, SD= .679) ($p \leq 0.05$) in scar thickness. This means applying the Tubi Grip and pressure garment on the hypertrophic scar site decreased the scar thickness among subjects in both U/S and MVSS measurements. But statically no significant differences were observed between the experimental and control groups pre and post-tests ($p \geq 0.05$). This means the Tubi grip and pressure garments have the same effect in reducing scar thickness using U/S and MVSS measurements.

Conclusion: This study has highlighted the effectiveness of two methods of pressure therapy in post-burn scar management and has identified that both techniques were effective with no significant difference in rehabilitation outcomes. The Tubi grip was a very cost-effective method of post-burn-scar thickness rehabilitation outcome.

Keywords: Burns, Hypertrophic Scar, Scar Massage, Modified Vancouver Scar Scale, and Ultrasonography.

فعالية ضاغط توبي مقابل اللباس الضاغط ضمن برنامج تأهيل الندب الجلدية بعد الحرق

اعداد: مهند محمد صالح منصور

المشرف: الدكتور أكرم عمرو

ملخص الدراسة باللغة العربية:

هوبحث هدفه دراسة تأثيرضاغط توبي واللباس الضاغط على الندب الجلديه والمقارنة بينهما للمرضى الذين تعرضوا للحروق. يقوم به اخصائي العلاج الطبيعي بهدف تحسين مستوى الندب الجلديه للمرضى وذلك من خلال تطبيق ضاغط توبي واللباس الضاغط ،و يعد كلا النوعين جزء اساسيا من برنامج تأهيل الندب الجلدية بعد الحروق. ويشتمل البرنامج على إعطاء تعليمات لذوي المرضى موضحا كيفيه تطبيق ضاغط توبي واللباس الضاغط على الندب الجلديه بعد الحروق مع ايضاح البرنامج الزمني وذلك تفاديا لاي مضاعفات ممكن ان تحدث . وسيكون المؤشر على مدى التحسن الذي حدث للندب الجلديه هو قياس الموجات فوق الصوتي ومقياس ندبة فانكوفر المعدل.

المقدمة: تعد الندب الجلديه والتي قد تكون نتيجه الإصابات الكدميه والإجراءات الجراحية وغالبا الحروق ، الخطر الأكبر بالنسبة للمرضى وقد تؤدي الى قيود اجتماعيه ونفسيه و وظيفية للمرضى بعد اصابتهم بالحروق. ومن جهة أخرى تشكل الندب الجلديه و بشكل كبير تحديا رئيسيا للمعالج الطبيعي و كذلك لجراحي التجميل. وقد تؤدي بعض الاجراءات العلاجية مثل تدليك الندب واستخدام شريحة السيليكون إلى تحقيق نتائج مفيدة وتساعد على تجنب ومنع التدخلات الجراحية. لذلك يعتيرضاغط توبي واللباس الضاغط إجراءات علاجية أساسيه للحد من الندب الجلديه بعد الحروق.

هدف الدراسة: تهدف هذه الدراسة إلى تقييم الفعالية العلاجية لضاغط توبي واللباس الضاغط والمقارنة بينهما من ناحية سمات الندب الجلديه التي تصيب المرضى بعد الحروق.

المنهج المتبع في الدراسة: سيتم استخدام تصميم تجريبي عشوائي متحكم في هذه الدراسة ،حيث سيكون قياس الموجات فوق الصوتي المقياس الرئيسي للنتائج، بالإضافة إلى مقياس ندبة فانكوفر المعدل. سيتم اختيار 30 مريضا بشكل عشوائي اعتمادا

على منهجية اخذ عينات منتظمة، حيث سيتم فصل المرضى وتقسيمهم إلى مجموعتين تجريبية و مجموعه مراقبة. حيث تشمل معايير الإدراج أن يكون المشاركون في كلتا المجموعتين بين 6 و 18 سنة، ويعانون من ندب جلديه في الأطراف العلويه اوالسفلية نتيجة تعرضهم للحروق،و سيتم الحرص على تلقي علاجهم في قسم العلاج الطبيعي في مستشفى رفيديا الحكومي كجزء من هذه الدراسة. سوف تحصل المجموعة التجريبية على العلاج من خلال استخدام ضاغط توبي بالإضافة إلى الإجراءات العلاجية الاعتيادية التي تتضمن التدليك اليدوي والجبائر وهلام السيليكون والتمارين اضافه الى استخدام كريم ترطيبي. أما بالنسبة لمجموعة المراقبة سوف تحصل على العلاج باستخدام اللباس الضاغط ، اضافة إلى الإجراءات العلاجية الاعتيادية كما في المجوعة التجريبيه. اجريت الدراسة في الفترة ما بين أذار– تشرين أول / 2021.

نتائج الدراسة: اظهرت النتائج تحسن معنوي في كلا المجموعتين بين نتائج الاختبار القبلي والبعدي ($P \leq 0.05$). وهذا يعني بأن تطبيق ضاغط توبي والمشدات الضاغطه ذات فاعليه في انخفاض مستوى الندب الجلديه بعد الحروق باستخدام مقياس الموجات فوق الصوتيه ومقياس فانكوفر المعدل. اضافه لذلك انه لا يوجد فرق معنوي بين كلا المجموعتين من حيث الفاعليه، اي ان استخدام ضاغط توبي واللباس الضاغط لهما نفس التاثير في انخفاض الندب الجلديه بعد الحرق ($p \geq 0.05$).

الاستنتاج: سلطت هذه الدراسه الضوء على التجربه المرتبطه بتطبيق نوعين من المشدات الضاغطه (ضاغط توبي و المشدات الضاغطه) على الندب الجلديه بعد الحروق. وقد اثبتت انه لا يوجد فرق معنوي بين ضاغط نوبي و اللباس الضاغط من ناحيه التاثير على الندب الجلديه بعد الحروق. ولكن تم استنتاج بأن ضاغط توبي ذات فاعليه عاليه من حيث التكلفة الماديه لإعادة تأهيل الندب الجلديه بعد الحرق.

كلمات مفتاحية: *حروق، الندب الجلدية، تدليك الندب، مقياس فانكوفر المعدل للندب الجلديه،مقياس الامواج فوق الصوتيه.*

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Abbreviations

MOH: Ministry of Health.
TBSA: Total Body Surface Area.
BMI: Body Mass Index.
ROM: Range of Motion.
PGT: Pressure Garment.
MVSS: Modified Vancouver Scar Scale.
U/S: Ultrasonography.
imp.US: Scar thickness improvement in the ultrasound.
imp. MVSS: Scar thickness improvement in the Modified Vancouver Scar Scale

Chapter One: Introduction

1.1 Background

The skin is acknowledged as being "the largest organ in the human body", and is extremely complex. The epidermis consists of stratum basale, spinosum, granulosum, and corneum, provides a bacterial barrier. The dermis provides elasticity and mechanical resistance. The thin epidermal layer is refreshing itself from its basal layer, with new keratocytes undergoing terminal differentiation, which provides the mechanical barrier function of the epidermis. The basal layer of the epidermis is firmly attached to the dermis by a complex bonding mechanism (dermo-epidermal junction). (Herndon, 2018).

The scar may be caused by a burn. A burn is "is an injury to skin or other tissues, caused by heat, cold, electricity, chemicals, friction, ultraviolet radiation (sun burn)" (WHO, 2016). Most of burns are due to heat from hot liquids, solids or fire (Granger J, 2009); these are potentially the most severe form of injury especially high- voltage electrical burn and flame burn, that has affected mankind. Scientific research has greatly improved treatment outcomes*"*(JA et al., 2017)**.**

The approach to burns is dependent on the severity of burns which is determined by cause and degree of injury and percentage of burn. The causes of burns are determined by etiology for example flame, scald, contact, chemical, electric high voltage (>1000 volts), and low voltage (< 440 volts) (JA et al., 2017)**.** Burn classification is based on their depth; first degree burns (Erythema) Affected the outer layer of the epidermis, superficial dermal burns extend to the papillary dermis, deep dermal burns extend to the reticular layer, and full- thickness burns extend to the cutaneous layer and may be to the subcutaneous layer (Herndon, 2018)**.**

Children are particularly vulnerable to burns. In addition, burns are the fifth most common cause of non-fatal childhood injuries, they influenced by the differences of culture, resource

availability and medical practice (Herndon, 2018). Regional differences are also considered as another risk factor where burn rates are more common in the African region where it is two times higher than the global incidence (especially in children less than five years of age); on the other hand boys under five years of age living in low- and middle-income countries of the WHO Eastern Mediterranean Region are almost two times as likely to die from burns compared to boys who are living in the European Region (Ai et al., 2016).

People living in low- and middle-income countries are at higher risk for burns than people living in high-income countries (WHO, 2018). Within all countries, however, burn risk correlates with socioeconomic status (WHO, 2018). Other minor risk factors for burns include occupations, poverty, lack of safety measures, alcohol abuse and smoking, chemicals, and electricity (WHO, 2018).

Burn complications can be long lasting. Burn scar can be disfiguring and aesthetically unpleasant and cause severe itching, tenderness, pain, sleep disturbance, anxiety, depression, and disruption of daily activities. Other psychosocial risks include developing post-traumatic stress reactions, loss of self-esteem, and stigmatization, leading to diminished life quality besides physical deformity due to skin scar contractures (Bloemen et al., 2009). The burn may cause serious complications, such as mortality or deformity. An estimated 180 000 deaths every year are caused by burns; the vast majority occur in low- and middle-income countries. At the same time, non-fatal burn injuries are a leading cause of morbidity. They occur mainly at home and at work and even they are preventable (WHO, 2018).

Skin reconstruction post injuries of traumas, wounds, incisional cuts, and burns occur due to a biological process as a result of the natural healing process. Scars are considered to repair the normal continuum to mammalian tissue as an endpoint of a new structural tissue function's total regeneration as the original intact skin (Brockes et al., 2001). Scars are described as “mature or

immature and the scarring process as normal or abnormal" (Alizadeh K, et al.,1998). Normal scarring is the final result of the wound healing process, and is formed in the remodeling phase. (Alizadeh K, et al.,1998). A normal scar is usually flat and narrow than the surrounding skin. But the abnormal scarring is formed due to local factors, and unfavorable scar can raise (Alizadeh K, et al.,1998).

The most typical types of scar formation are mature scar which is flat scar and light- colored (Mustoe TA, et al., 2002). Immature scar is still in the healing process (remodeling phase), even it looks linear hypertrophic scar (Mustoe TA, et al., 2002). Linear hypertrophic scar that is red, elevated, and sometimes itchy and happened after surgical incision (Mustoe TA, et al., 2002). Widespread hypertrophic scar which is red, elevated, and itchy scar raised to the border of the burn injury, and happens mainly after burns (Mustoe TA, et al., 2002). Minor keloid is actually raised, and itchy and may develop up to 1 year, and major keloid is a large, elevated (> 0.5cm) scar, often painful, and this results after minor trauma and continue to spread for years (Mustoe TA, et al., 2002).

Accuracy of scar assessment plays a vital role in scar management. Performing correct scar diagnosis helps to start ideal scar monitoring and reevaluation periodically in order to select the proper therapeutic strategy of scar management. Therapeutic strategy decision depends on site of the anatomical location of the scar, depth, total body surface area burned (TBSA), symptoms such as pain and itching, the severity of functional impairment such as joint mobility, and stigma of how much is the patient disturbed (WHO, 2018).

Scar management is a challenge despite the application of different treatment procedures. Both pharmacological and physical therapy, as well as surgical interventions, are employed with varying outcomes and effectiveness (Gold et al., 2014). The nonsurgical methods include Massage,

Silicone gel or sheeting, Vitamin A or E, Pressure therapy, Herbal extracts (Allium cepa, madecassol), Steroid injection (triamcinolone), Antimitotic (bleomycin, 5- fluorouracil), Laser (585- nm flashlamp- pumped pulsed dye, carbon dioxide), Soft tissue augmentation, Radiotherapy, Interferon, Cryotherapy, and Makeup camouflage (Chang CW, et al., 2001).

Pressure garments have been the mainstay of treatment for hypertrophic scars in burn injuries (Steinstraesser et al., 2011). They are made from elasticized fabrics, and the mechanical pressure by applying pressure between 6 and 50 mmHg, but the manufacturers of pressure garments for post- burn hypertrophic scar provide 25 mmHg. It is usually used to treat or prevent pathological conditions. The mechanism of pressure garments to reduce hypertrophic scar scientifically still unproven. But there is a theory that the restriction of blood supply, oxygen and nutrients will reduce scar thickness (Atiyeh et al., 2013). Local application of Tubi grip is another alternative approach for pressure therapy (Mangano, 2011). Other therapeutic techniques include friction massage, splinting, exercises, silicone gel, and lubricant (moisturizing cream).

1.2 Problem Statement

Burns management include several techniques and approaches, that are aiming to decrease post-burn complications, that include none functional scar formation, which causes limitation of movement, pain, functional restrictions, and psychological consequences. All of these techniques aim to achieve the best outcome by using different approaches to manage post-burn scar cases.

Therefore, there is a crucial need to investigate the best effective rehabilitation approach in terms of outcome and cost-effectiveness, to address a gap in the body of knowledge regarding two rehabilitation approaches in the management of post-burn scars, which are the verifying Tubi grip vs. pressure garments. To date there is no research information, regarding the outcomes of the two approaches.

There are no previous studies conducted in Palestine (up to the researcher's knowledge) that investigated the factors contributing to better outcomes regarding the management of abnormal scar post-burn. This study aims to investigate the difference in the outcome of those two management methods, and will contribute to the knowledge that can lead to a better scar prognosis in burn patients.

1.3 Study Hypothesis

The Null hypothesis (H0): There is no statistically significant better outcome for the use of Tubi grip versus pressure garments post-burn hypertrophic scar at the level of P≤0.05.

The alternative hypothesis (H1): There is a statistically significant better management outcome for the use of Tubi grip versus pressure garments post-burn hypertrophic scar at the level of P≤0.05.

1.4 Study Objectives

1. To investigate the effectiveness of Tubi grip versus pressure garments in the rehabilitation program of post-burn hypertrophic scar.
2. To investigate the personal variables affecting prognosis in the post-burn hypertrophic scar.

1.5 Significance of the Study (Study Justification)

Burn reconstruction and rehabilitation are difficult and time-consuming processes; hypertrophic scar has always been the top priority of post-burn intervention, and expanding the knowledge in understanding the most effective management of hypertrophic scar, will decrease the potential disability and impairment that may be caused as a complication of burns, and conduct evidence-based rehabilitation to minimize this impact (Atiyeh et al., 2013) (Esselman, 2007)(Capek et al., 2018).

Therefore, the results regarding the effectiveness of these two common approaches will enhance burn patients' ability to function more effectively and restore their body image. The results of this study will be also beneficial for Health care professionals, physiotherapists,

doctors, and also MOH that may use the results of this study to develop a potential management protocol of hypertrophic scar post burns.

1.6 Terminology

- **Burns**: "are a type of injury to skin or other tissues, caused by heat, cold, electricity, chemicals, friction, ultraviolet radiation like (sun burn). Most of burns are due to heat from hot liquids, solids or fire" (WHO, 2016).
- **Scar: "is** the trace of a healed wound, sore or burn. A fault or blemish remaining as a trace of some former condition or resulting from some particular cause" (van Zuijlen PP, et al., 2002)
- **Hypertrophic scar management:** "requires input from a multidisciplinary team working together to optimize physical and psychological recovery of patients". (Richard et al., 2009).
- **Pressure garments:** "a garment that applies continual pressure over large areas of healing skin after burns, trauma, and surgical intervention; it limits hypertrophy and contraction of scar tissue. Also, are the first-line of pressure therapy since the 1970s". (Atiyeh et al., 2013)(Bloemen et al., 2009) (Van den Kerckhove et al., 2005) .
- **Tubi grip: "**is an easy – to – use compression bandage that is excellent in the treatment of sports and soft tissue injury. It is used for pressure in the treatment of post- burn scarring". (Granick & Téot, 2012).

1.7 Summary

In this chapter of the study, the reader was able to identify the main reason for conducting this study to be undertaken problem statement, research hypothesis, study objectives, study justification, and variables definition. The problem was discussed in this chapter. Therefore, the understanding of the problem concerned not only physiotherapists but other health care staff.

Chapter Two: Review and related literature

2.1 Theoretical Framework

Burn injuries most often result from disastrous events and may leave the individual with multiple impairments, this will require intensive treatment and rehabilitation (Coghlan, 2019). Burn injuries can lead to a wide range of physical and psychological changes for the patient, including the progress of hypertrophic scar. Hypertrophic scars make a difference to surrounding healthy skin when raised, and have a different pigmentation (Tredget et al., 2014). If the maturation process of hypertrophic scarring is untreated, the deposition of collagen fiber undergoes restructuring. This may cause skin contractures and scar-related problems such as movement restrictions, and itching (Ladak & Tredget, 2009).

2.1.1 Burn Injuries

Burn injuries are defined as “an injury to skin or other tissues, caused by heat, cold, electricity, chemicals, friction, ultraviolet radiation. Most of burns are due to heat from hot liquids, solids or fire” (WHO, 2016). Burn’s causes were categorized into flame burns invariably involve deep dermal or full thickness injury due to prolonged exposure to intense heat, scald burns (hot water scalds) are the most common cause of burns, and often cause superficial and intermediate deep burns. Whereas, hot oil scalding burn causes deep dermal or full-thickness injuries. Contact burns which result from glass, hot metals, and plastic are generally small, but the injury is often very deep. Chemical burns result from strong acids or alkaline, and cause progressive tissue damage. And electrical burns are thermal burns result from low- voltage injury (< 440 volts) and may cause to contact point deep thermal injury. But, high- voltage injury (> 1000 volts) cause deep tissue

damage (Herndon, 2018). The classification of burn injuries based on Total Body Surface Area (TBSA) is expressed as a percentage and relates to the size and the depth of the injury (WHO, 2007). The first- degree burns (Erythema) involve the outer layer of the epidermis, it is erythematous and very painful, but do not form blisters, recovery occurs within 3-4 days. Superficial dermal burns extend to the papillary dermis and form blisters, and heal within 2 weeks without risk of scarring. Superficial scalding burns should be managed nonoperatively within 10-14 days. Deep dermal burns involve the reticular dermis, the surface of the wound appears mottled pink, white, dry, and less sensitive. These burns heal within 3 weeks, and need grafting. The full-thickness burns extend to the cutaneous layer and may be into the superficial subcutaneous layer. Their appearance leathery, dry, firm, absent pain, and require surgical management (Herndon, 2018).

Figure 1. Shows primary damage caused by the thermal effect.

2.1.2 Process of scarring

During the wound healing process, scar formation occurs elaborately due to increased vascularization, cell migration abnormalities, synthesis of extracellular matrix proteins, and

changes to the wound healing matrix (Chang et al., 2008). These events can result in atypical orientation and collagen fibers synthesis, resulting in a hypertrophic scar (Tredget et al., 2014). Hypertrophic scarring is a common complication post-deep burn injury and usually develops within one to three months post-injury (Bloemen et al., 2009). The untreated hypertrophic scar, its collagen fiber underwent reorganization, causing skin contractures with other symptoms such as itching and heat intolerance (Tredget et al., 2014). The skin contracture appearance differs from the surrounding healthy skin; it became red ,raised with different textures as elevation, firmness, and transformed into the sensitive and itchy area (Tredget et al., 2014) (Anthonissen et al., 2016).

Figure 2. Shows process of hypertrophic scar.

2.1.3 Changes post-burn injury

Post-burn scar appearance has significant functional impacts on patients in numerous ways in their well-being, including their physical, psychological, and quality of life (Sliwa et al., 2005). Physical changes may occur due to inflexible and inelastic skin contractures; it includes a range of motion (ROM) associated with itching and an inability to tolerate heat, limiting joint ROM caused by skin shortening (Chapman, 2007). Around 18% of burn patients suffer from limited ROM post-burn incident and may continue long after injury around five years (Anthonissen et al., 2016) (Fauerbach et al., 2005) (Pallua et al., 2003).

Burn patients reported discomfort while working, recreational activities, and troubles with their sleep (Pallua et al., 2003)(Casaer et al., 2008). The inability of burn patients to tolerant heat due to blood vessels damage leads to limiting individuals' ability to control their temperature (Ganio et al., 2013). ROM restriction occurred among patients who were exposed to burn. Many roles in their daily lives are disrupted post-burn occurrence, including self-care tasks, employment, and leisure activities(Richard et al., 2009).

2.1.4 Scar Management

Hypertrophic scar impact varied on patients' life with the burn. Most patients with burns focused on scar management in their rehabilitation (Esselman, 2007)(Capek et al., 2018), and it requires multidisciplinary teamwork to optimize the physical and psychological recovery of patients (Richard et al., 2009). Hypertrophic scar management remains an enduring area of research. The management of scar strategies applies silicone, intraregional steroids, massage, and compression garment therapy topically (Richard et al., 2009)(Esselman, 2007) (Ogawa, 2010). Compression garments are considered the first-line therapy to manage the hypertrophic scar since the 1970s (Macintyre & Baird, 2006)(Van den Kerckhove et al., 2005), that exert pressure on the tissues to influence scar formation and progression and be smaller (Tredget et al., 2014)(Macintyre & Baird, 2006). The mechanisms depend upon a firm fit to influence scar growth, to reduce the amount of collagen (Tredget et al., 2014) (Anthonissen et al., 2016), by reducing blood flow to the area, which limits the supply of nutrients and oxygen to scar tissue and inhibits growth (Bloemen et al., 2009)(Chapman, 2007) .

Figure 3. Shows process of hypertrophic scar.

2.2 Similar studies

Pressure therapy has been considered a standard, and gold method of physiotherapy intervention for the treatment of hypertrophic scarring since the year of 1970s. Although it is widely used, the pressure therapy technique has been based on strong evidence supported by scientific studies (Atiyeh et al., 2013). The clinical question was among patients with hypertrophic scars post-burn, does pressure therapy reduces scar thickness improves functional outcomes (Sharp et al., 2016).

2.2.1 Global Studies Related Burn Injuries

Burns are the fifth most common cause of non-fatal childhood injuries among children living in low- and middle-income countries of the WHO Eastern Mediterranean Region, they are almost two times as likely to die from burns as compared to boys who are living in the European Region (WHO, 2018).

(Rose & Deitch, 1983), studied the clinical use of a tubular compression bandage, Tubi grip, in 23 pediatric burn patients. Twelve of the children (52%) were under age three years, and the mean TBSA burn was 23% (range 3% to 70%). They concluded that the most effectively hypertrophic

scar sites treated were flat circumferential sites, including the upper extremity, and lower extremity. Although Tubi grip has not completely replaced Jobst garments, it has added a new therapeutic dimension to traditional compression methods in selected pediatric burn patients.

(Kealey, et al., 1990), compared two types of pressure therapy garments. The authors aimed to compare the adjustable nylon pressure garment's compliance efficacy and cost with the cotton elastic pressure garment Tubi grip. One hundred and ten patients were enrolled, 54 patients received pressure garments, and 56 received Tubi grip pressure garments. Both groups spent the same pressure-therapy garments time. They concluded that the Tubi grip garments' treatment cost was lower significantly than the other group. They recommended using elasticized cotton pressure garments Tubi grip which had better patient compliance at a lower cost with identical therapeutic efficacy than nylon pressure garments.

(Tawfik, et al., 2018), studied the therapeutic effectiveness of kinesio taping and deep friction massage on hypertrophic scar post burned patients. Thirty patients between 20 to 45 years who had a forearm hypertrophic scar were included in this study. The author concluded that Kinesio taping was more effective in reducing scar thickness and cosmetic appearance compared with deep friction massage however both methods are considered as an effective therapeutic tool in the management of post burn hypertrophic scar.

(Van den Kerckhove et al., 2005), the author compared two types of pressure: 10 and 15 mmHg. Scarring was assessed objectively on a monthly basis and for a total follow-up of three months to

assess and evaluate scar maturation assessment. The authors discovered a significant improvement of scar thickness when they used a pressure of 15 mmHg compared with 10 mmHg.

In contrast,(Anzarut et al., 2009), reviewed to assess the quality of available evidence of PGT using a meta-analysis method to measure PGT clinical effectiveness. They concluded using PGT improved scar thickness, but the beneficial effects of PGT remain unproven. They recommended additional research is required to examine the effectiveness, and cost of PGT to give current evidence. This result was confirmed by (Tredget et al., 2014), they noted that the effect in scar thickness is observed by using a part of a multimodality scar management program, but still, no definitive solution was provided.

(Candy et al., 2010), the author compared two types of different pressure magnitude a high-pressure group (20–25 mmHg) and low-pressure group (10–15 mmHg) for a five-month intervention program. To evaluate the efficacy on hypertrophic scar. Who concluded that High pressure was more effective for scar management, but pressure therapy integrated with regular monitoring of the interface pressure.

(Kim et al., 2015), concluded that Pressure garment therapy significantly hindered the scar contraction when they were compared to control scars, and significantly reduced skin hardness. They recommended that pressure garment therapy was effective in reducing scar contraction and improving biomechanics compared to control scars.

(Sharp et al., 2016), the author aimed to create relevant literature to conclude recommendations for the use of pressure therapy in individuals at risk of hypertrophic scar. They used a systematic search of the literature of a total of 45 articles that were found and critiqued from the dates of January 1950 – to February 2014. The authors concluded that pressure therapy is utilized to decrease scar thickness in burns requiring 14 to 21 days to heal, for 23 hours/ day for 12 months, fit to achieve 20 to 30 mmHg of pressure, fit by a profession, and replaced every 2-3 months. The recommended pressure therapy is not used to treat abnormal pigmentation, nor used to improve scar maturation. Also, they recommended the consistency and efficacy of pressure therapy utilization at the point of care.

(Li et al., 2018), the author studied the recovery of post-burn hypertrophic scar in a monitored pressure therapy intervention program and the timing of intervention. They noted that early application of pressure therapy after burn injury may contribute to better outcomes as shown by their faster recovery than those with late intervention, to achieve the best outcomes, regular evaluation and adjustment for optimal interface pressure are necessary.

(Houschyar et al., 2019), about the effect of Obesity on the treatment outcomes of severe burn patients. They concluded that the increasing prevalence of obesity will affect progressively in burn care, and the complications of Obesity may influence the consequences in the two stages of treatment in acute and long-term burn management. In addition to the difficulties that may occur during the treatment process. The researchers are recommending, further research in this finding is required and must take into consideration the characteristics post-burn to identify the effect of BMI on post-burn scar tissue, to allow therapy based on scientific evidence.

(DeBruler et al., 2019), the author studied the role of early application of pressure garments following burn injury and auto grafting. They aimed to investigate the reduction of post-burn scarring after complete healing of the wound or autografts. They treated the grafts with pressure garments immediately, one week (early), or five weeks (delayed) after grafting with non-treated grafts as controls. Scar maturation and biomechanics were measured multiple times up to 17 weeks after grafting. They concluded that early application of pressure garments reduced scar thickness, decreased contraction, and improved biomechanics compared with non-treated grafts as controls. They recommended that employing the early application of pressure garments is safe and effective for reducing scar thickness and contraction and improving biomechanics, and they also suggested that pressure garments should be applied as soon as possible after grafting to achieve the most significant benefit, although clinical studies are needed to validate humans' findings.

(Mohammed & Abolwafa, 2019), the author aimed to evaluate using of pressure garments versus hospital routine care in reducing scars immediately after-burn surgery. They discovered a significant observable improvement of scar thickness among the study group after using pressure garments immediately post-burn surgery during follow-up (3,6, and 9 months). They recommended that the pressure garments were an effective method in reducing post-burn hypertrophic scar in the study group.

(Lee et al., 2019), the author aimed to evaluate 55 scar and normal skin sites using subjective Modified Vancouver Scar Scale (MVSS), Patient and Observer Scar Assessment Scale (POSAS) and objective tools by independent assessors. They concluded that the objective scar measures

demonstrated excellent intra- and inter-rater reliability and accuracy compared with the subjective scar scales.

(Das et al., 2020), who aimed to evaluate the efficacy of silicone gel alone with comparing the use of silicone gel along with customized pressure garment locally for 6 months on widespread hypertrophic scar. The author concluded that silicone gel alone is sufficient for small scar, but for widespread hypertrophic scar should be used silicone gel along with pressure garment therapy.

(Elrefaie et al., 2020), the author aimed to compare the value of the high-resolution ultrasound with comparing to the Vancouver Scar Scale (VSS) in the assessment of the scars. Twenty-two patients with hypertrophic scar were included in the study and evaluated by the high–resolution ultrasound and the Vancouver scar scale. They concluded that the Vancouver Scar Scale and the high-resolution ultrasound help assess the hypertrophic and keloid scars and compare the effectiveness of different treatment modalities.

(Tsai et al., 2022), studied high-frequency ultrasound in the assessment of skin and scars. The researcher concluded that the high-frequency ultrasound has a great probable outcome for progressing the accuracy in the clinical diagnosis of hypertrophic scarring.

(Ud-Din & Bayat, 2022), recommended further investigations, regarding a potential tool that can play as a predictor for the accuracy of scar thickness evaluation, which allows early diagnosis, application of therapy, and improvement of the hypertrophic scar post-burn. Also, they recommended for future research to investigate the possibilities of using further technology in the

evaluation of the post-burn scar thickness that represents the best outcome measure for a post-burn rehabilitation program.

2.2.2 Local studies of burns

One study was found within the Palestinian context (Qtait, 2019); they studied the prevalence and epidemiological of burns in Hebron, Palestine. The authors aimed to know the prevalence of burn in Hebron government hospitals to provide guidance for burn prevention and reduce burns in Hebron and West Bank. They discussed the epidemiology of patients in the burn unit between 2016 and 2017. They concluded that most of the children under 14 years old, females, incidents occurring in winter, and scald burns should receive more attention to prevent burn injuries. They recommended that scalding was the most crucial cause of burns among Palestinian children would reduce burn injuries among children.

2.3 Summary

In this chapter, the researcher reviewed the available studies that will be evaluated by pressure therapy methods with patients who sought intervention therapy post-burn. This review's findings reveal a lack of extant literature on pressure therapy within the Palestinian research context. More research is needed as an evidence-based practice to prove the therapeutic effect of pressure therapy among this target population of burn patients. Previous studies among Palestinian physiotherapists are rare. In the next chapter, the methodology will be discussed.

Chapter Three:

Methods and procedures

3.1 Study design

This study was a randomized control trial, blinded for (Ultrasonography- Radiologist), to assess the clinical effectiveness of Tubi grip vs. pressure garments on post-burn hypertrophic scar rehabilitation outcome. This study design was adopted as it is the gold standard design in medical intervention effectiveness studies.

3.2 Research setting

The study was performed at the Physiotherapy Department/ out-patient clinic at Rafedia hospital in Nablus, West Bank, Palestine. Rafedia Surgical Hospital is a government hospital in Nablus city, West Bank, Palestine. Governed by MOH law; Palestinian Ministry of Health. It was established in 1976, with a capacity of 200 beds. It is composed of surgical wards (orthopedic surgery, neurosurgery, plastic, and reconstruction surgery. The burn unit in Rafedia Governmental Hospital consists of 10 beds, and it is the central unit in the West- Bank.

3.3 Study time frame

The study was conducted from March to October 2021. This study took place in the out-patient clinic of the physiotherapy department at Rafedia Governmental Hospital.

3.4 Study population and sample

The sample was a convenient sample of the patients exposed to burns and got their follow-up treatment at Rafedia governmental Hospital in the West Bank, Palestine. The participants with post-burn hypertrophic scar were included in the study.

3.4.1 Sampling method

The recruitment of the sample was through a convenient sampling method, for this RCT, then the Excel was used to randomize the 30 participants' codes (1-30) into either experimental (n=15), or control group (n=15).

3.4.2 Sample size

Thirty patients were recruited to this study. This number is the minimum sufficient sample size for the intended inferential statistics to be used in the data analysis of this research.

3.4.3. Inclusion criteria

The patients who fulfilled the following criteria was recruited and invited to participate in this study.

- Age between 6- 18 years.
- Post-burn upper extremity and lower extremity hypertrophic scar.
- Hypertrophic scar, after the burn wound has healed, more than 3 weeks.
- Total Body Surface Area > 5% - < 30%.
- Has a referral to physiotherapy form from the plastic surgeon.
- The guardian of the patient who will sig. the consent form.

3.4.4. Exclusion criteria:

The exclusion criteria will be as follows

- Patients < 6 and >18 years will exclude from the study.
- Total Body Surface Area < 5% or >30%, will exclude from the study.
- Skin sensitivity.
- The open wound at/ or near the treatment site.
- Fragile skin.
- History of malignancy or carcinoma of the skin in the area of treatment.
- The patient had cardiac disorders.
- Vascular system insufficiency.
- Musculoskeletal disorders.

3.5 Data collection

3.5.1 Tools of data collection

Data collection sheet:

For the study, after critically reviewing the literature, the researcher developed a data collection sheet composed of 3 parts;

- Complete socio-demographic information; composed of 11 items to assess age, gender, occupation, height, weight, BMI, cause, degree, site of the burn, and TBSA.
- Past medical and History neurological deficits.
- Surgical history characteristics.

- ***Vernier Caliper:***

This device is used to measure the dimensions of an object, and it is used in many fields such as science and medicine…etc. Calipers often have a "zero-point error"(Singh & Chaturvedi, 2016). Vernier calipers are the most accurate tool used as a method to determine human diameter specimens and can be used directly and easily by using manual measurement present with Vernier calipers (Muteti & ElBadawi, 2018) · A Vernier is a short scale that is mounted on a measuring instrument so that its graduations subdivide the divisions on the main scale. Vernier increases the degree of precision which can be obtained from both linear and angular measuring tools. The French mathematician, Pierre Vernier, invented the Vernier scale in about 1630 A.D(Singh & Chaturvedi, 2016).

Scoring: it has two types of scales- a fixed main scale and a moving Vernier scale. The main scale is normally in millimeters or 1/10th of an inch. Vernier calipers score well over standard rulers because they can measure precise readings up to 0.001 inches(Singh & Chaturvedi, 2016).

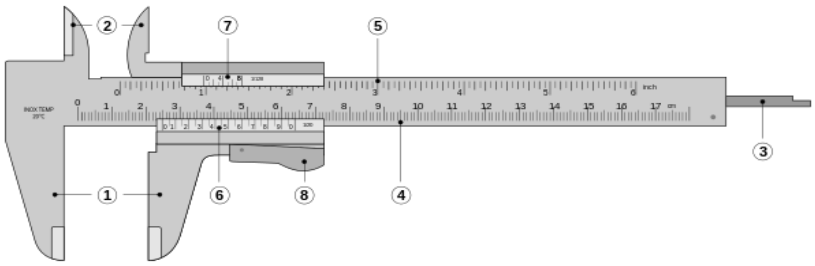

Figure 4. Shows Vernier caliper.

Ultrasonography (Philips EP1Q5 Diagnostic Ultrasound System):

Is used to measure the deep dermal and full-thickness burn wounds (hypertrophic scar), that were not healed spontaneously within 3 weeks (Iraniha et al., 2000). The patient lies down on the table

with a hypertrophic area exposed. The Ultrasound Radiologist will rub ultrasound transducer on the skin after special gel has been applied on the examined area. The report about scar thickness will be received for each patient and then will be examined(Tawfik, et al., 2018).

Modified Vancouver Scar Scale:

It is a valid and reliable tool that was used to measure the characteristics of the scar Vascularity, Pigmentation, Thickness, and Pliability by using the Modified Vancouver Scale (Thompson et al., 2015), to measure therapy outcomes. Therapist's results of using the Vancouver scar scale among patients showed that the height of the scar proved to be accurate(Thompson et al., 2015). Researchers stated that the finding needs to be validated through in-person scar assessments(Thompson et al., 2015). Scoring on pigmentation, vascularity, pliability, and height was undertaken for the 'best' and 'worst' areas of each scar. Categories for modified Vancouver scale are **(<5: best, 5–10: worse, >10: more worse)** (Thompson et al., 2015). The Modified Vancouver Scar scale will be the secondary outcome measure.

3.5.2 Data collection procedures.

Ethical clearance was granted from Al-Quds University and a permission form MOH was obtained, then recruitment of the participant started, then distributing the patients into two group's experimental and control group was performed based on random allocation of using codes between 1-30, the started to fill the personal data of each patient in the first day of assessment. Also started to measure the thickness of the scar by ultrasonography which was the primary outcome measure, scar characteristics by using the Modified Vancouver Scar Scale was performed as the secondary

outcome measure. Measurements were taken before starting the study (pre-test measure), and after two months of intervention (post-test measure) in both groups.

3.6 Suggested program

The experimental group will receive

- Applying the Tubi grip on the hypertrophic scar site, based on scientific evidence to treat hypertrophic scar post-burn injury, the technique was applied through two treatment sessions per week, for two months. After wound closure (Esselman, et al., 2006).
- In addition to the regular rehabilitation program of friction massage, skin stretching technique, silicone gel, exercises, lubrication, and home program.

The Control group will include

- The pressure garments therapy, which was applied on the hypertrophic scar site, based on scientific evidence for the treatment of hypertrophic scar post-burn injury technique was applied in the two treatment sessions per week, for two months. After wound closure, pressure therapy amount, 15- 24 mmHg, tested by (sphygmomanometer), by applying the calf of sphygmomanometer on the opposite limb of the participant to make him/ her feels the same pressure with comparing the pressure therapy method(Harries & Pegg, 1989). The period of wearing pressure garments 23 hours a day(Mehta et al., 2019).
- In addition to the regular rehabilitation program of friction massage, skin stretching technique, silicone gel, exercises, lubrication, and home program.

Table 3.1 Physiotherapy intervention procedure will be applied as follows:

Intervention	*Consist of*	*Time*	*Precautions*
Tubi grip	- Compression is applied when the wound is completely healed. - The Tubi grip is worn 23 hours a day and is readjusted every 3 to 5 days. - **Pressure amount** 10-15 mmHg - The Tubi grip is usually used as a double thickness (Van den Kerckhove et al., 2005). **- Low cost.**	15minutes	- Pain. - Sensitive skin. - Open wound. - Compression is less than 15mmHg.
Pressure garments	- Compression is applied when the wound is completely healed. - The optimal pressure on the skin is 15- 24 mmHg. - Pressure garments are worn 23 hours a day(Moore et al., 2000). - **Very expensive.**	15 minutes	- Pain - Sensitive skin. - Open wound. - Compression less than 15mmHg.
Deep friction massage	- Before starting clean hands and no bleeding present. - The therapist's fingers and the patient's skin must move simultaneously to avoid injury. - The massage application perpendicular to the tissue fiber to smooth the scar down(Tawfik, et al., 2018).	According to the hypertrophic area extend. (10 seconds for 1cm * 1cm).	- Unhealed wounds or an infection - Massage treatment will stop if there is a break in the skin. - Discomfort.
Splinting	- Splints will be worn at night until the scar is mature and during the day when the scar is active. - Gradually the day regime includes more periods with splints off e.g., two hours on, two hours off. - Any loss of range requires splinting to prevent further progression. - Splinting position at end of the range or close to can be tolerated well in children (*Burn Physiotherapy and Occupational Therapy Guideline, 2017*).	According to the hypertrophic site, and progression.	- General observation and circulation. - advise ROM exercises before splint application
Exercises - **Passive exercises** - **Active exercises.** - **Active assisted exercises.** - **Active strengthening exercises** - **Stretches exercises**	- **Active ROM** is encouraged as soon as possible. - **Active-assisted ROM and passive ROM** are useful when the patient is unable to actively participate. - **Exercise frequency, intensity, time, and type** are all individualized. - Performance is dependent on the patient's pain tolerance, scarring, and motivation. **Aim to perform exercises several times a day.** - Integrate exercise into ADLs. **More frequent exercise is better than just one long session.** - **Stretches need to be low repetitions**. - It is essential that stretches are observed **without garments in place**. - Stretching will include **multiple joints**. (*Burn Physiotherapy and Occupational Therapy Guideline, 2017*).	According to the hypertrophic area extend, and patient tolerance.	- The impact of overheating and sweat on skin integrity must also be considered. - Pain.
Silicone Gel	- To be applied on clean, dry skin. - Applied twice daily on the site of hypertrophic scar, at rest time, from Tubi grip and pressure garment wearing (*Burn Physiotherapy and Occupational Therapy Guideline, 2017*).	5 minutes.	- Infected area. - Skin sensitivity.
lubrication ***(Moisturizer cream).***	Applied three-five times daily on the site of hypertrophic scar (Tawfik, et al., 2018).	5 minutes	- Infected area. - Open wound. - Component's sensitivity.
Home program	- Monitoring by family, evaluation of pressure effectiveness. - Physio instructions paper will be given to the patient or family. (Training and *instructions).*	- Procedure will be explained to the family.	-Precautions will be explained to the family.

3.7Statistical analysis

The collected data were captured and analyzed using the Statistical Package for Social Sciences (SPSS) Version (26). Data entry was performed by the researcher and double-checked for outliers or errors. Data were tested for normality by using the Shapiro-Wilk tests.

Data analysis of descriptive and inferential statistics was conducted. Regarding descriptive statistics, frequency, percentages, mean score, Standard Deviation (SD), and Chi-square test were used to describe the study variables. Regarding inferential statistics, the parametric tests included the Paired t-test to assess the effectiveness of Tubi Grip and pressure garments therapy in terms of scar thickness and an independent t-test was used to compare the differences between the groups (experimental and control groups) for the continuous (scale) variables. According to the correlation, the researcher used Pearson correlation in continuous variables. Finally, the researcher calculated the Improvement by calculating the difference between the pretest, and posttest. and multivariate regression was applied to investigate predictors of the different burn management outcomes. P-values was set at ≤ 0.05.

3.8 Ethical consideration

Ethical clearance was granted from the ethical committee of Al-Quds University, based on the researcher's commitment to comply with all the ethical codes of Helsinki, represented in the guarantee of the participant's privacy, and dignity.

The participant received a study information sheet (Appendix 1) that explained all the objectives, and procedures of the study. Consent forms were signed by the guardian of each participant

(Appendix 1), ethical codes of research were declared, including the right of the participants to withdraw at any stage and at any time, without any harm to their interest's obligation to explain their withdrawal. Anonymity and privacy were insured, and data was secured in a locked closet that no one except the researcher had access to.

In cases where the participant was under the legal age to sign, their searcher obtained (guardian) approval with their signature on the study consent form for patients, and they were urged to ask directly any inquiries or seek any clarification. Administrative approval was obtained from the Palestinian ministry of health, no names were mentioned in the analysis, the data was secured with limited access of the researcher only, and the data was used only for scientific purposes. The results of this study will be accessible and delivered to the participants of this study.

3.9 Summary

The following chart (figure 3.2) explains the process of recruitment and intervention.

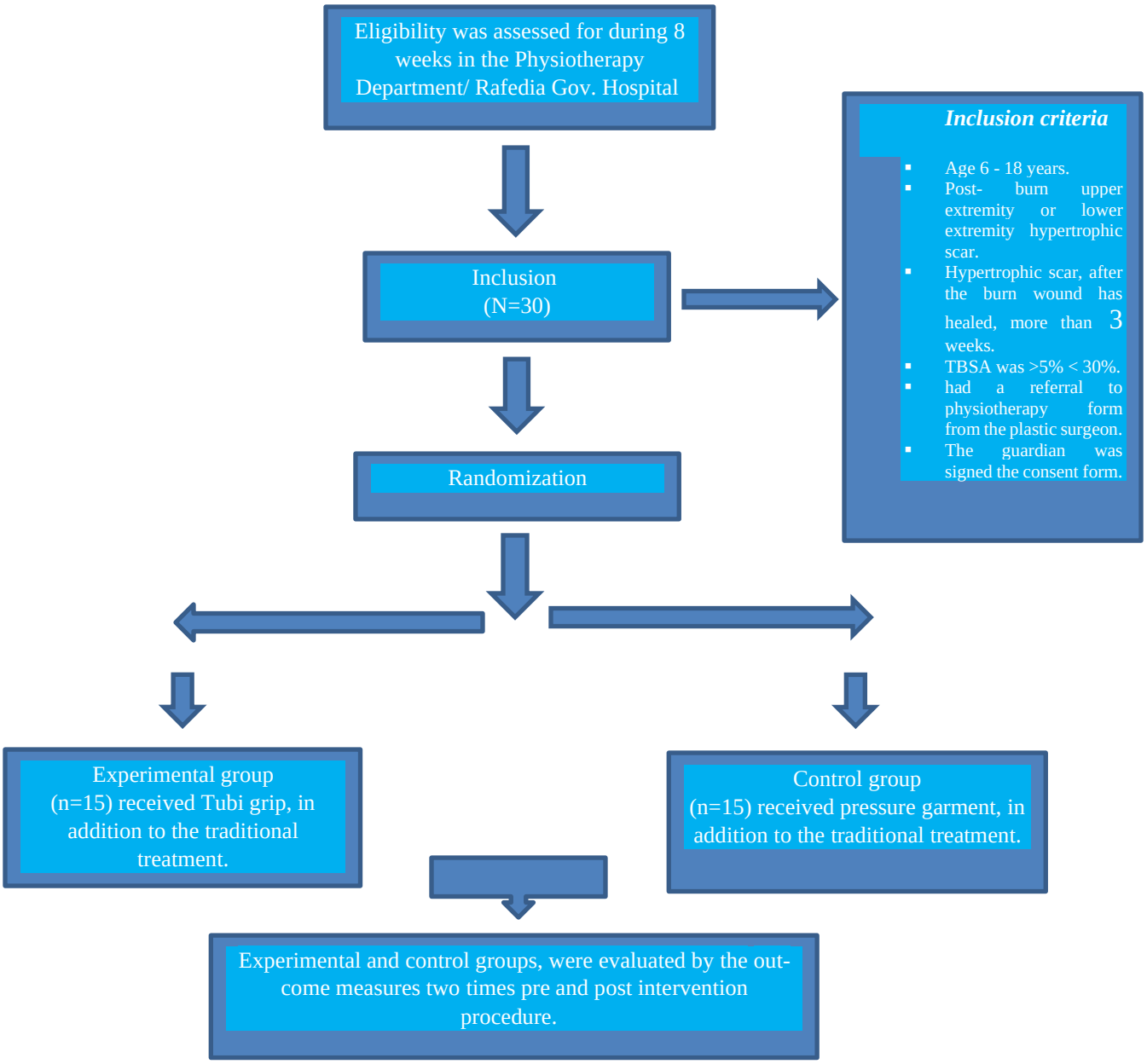

Figure 5. Shows patients recruitment in the current RCT.

Chapter Four

4.1 Results presentation and analysis

4.1.1 Descriptive statists of personal variables

Table 4.1: The study sample was divided into two groups, experimental and control groups, each group has 15 participants. The experimental group included (**15**), **(7) 46.7%** Males and (**8**), **53.3%** Females, also the control group included (**15**), **(9) 60.0%** Males and (**6**), **40.0%** Females. Whereas most of the participants were students **(80%)** in both groups (experimental & control groups). In terms of BMI, the majority of the participants in both groups were underweight **(73.3%).**

Table 4.1 ***Descriptive statistics of Socio-demographic characteristics of the categorical variables of both groups.***

Socio-demographic Characteristic's	Experimental Group (n=15) n (%)	Control Group (n=15) n (%)
Gender		
Male	7 (46.7%)	9 (60.0%)
Female	8 (53.3%)	6 (40.0%)
Occupation		
Students	12 (80.0%)	12 (80.0%)
Unemployment	1 (6.7%)	1 (6.7%)
Employment	2 (13.3%)	2 (13.3%)
BMI Categories		
Underweight (< 18.5)	11 (73.3%)	11 (73.3%)
Normal weight (18.5- 22.9)	4 (26.7%)	3 (20.0%)
Over weight (23- 24.9)	0 (0.0%)	1 (6.7%)
Obese (25- 29.9)	0 (0.0%)	0 (0.0%)
Extreme obese (≥30)	0 (0.0%)	0 (0.0%)

4.1.2 Descriptive variables of the burn

Table 4.2. Presents the descriptive characteristics of the burn-in both groups, most of the experimental group had a scald burn (73.3) %. While most of the control was complaining from flame burn (66.7%), in terms of the degree of pain, there were no 1st-degree participants in either group, and the majority of the participants in both groups had a 2nd-degree burn. In both groups, the upper extremity was more dominant.

Table 4.2 Descriptive statistics burn characteristics of both groups

Socio-demographic Characteristic's	Experimental Group (n=15) n (%)	Control Group (n=15) n (%)
Cause of Burn		
Flame burn	3 (20.0%)	10 (66.7%)
Scald burn	11 (73.3%)	5 (33.3%)
Chemical burn	1 (6.7%)	0 (0%)
Degree of Burn		
1st degree	0	0
2nd degree	13 (86.7%)	11 (73.3%)
3rd degree	2 (13.3%)	4 (26.7%)
Site of Burn		
Upper hands	6 (40.0%)	5 (33.3%)
Lower hands	4 (26.7%)	4 (26.7%s)
Both upper and lower limbs	3 (20.0%)	3 (20.0%)
Knee joint	1 (6.7%)	1 (6.7%)
Left forearm	1 (6.7%)	0 (0%)
Elbow joint	0 (0%)	1 (6.7%)
Left shoulder	0 (0%)	1 (6.7%)
Past Medical History		
Yes	15 (100%)	15 (100%)
No	0 (0%)	0 (0%)
Type of Medical History		
Burn	15 (100%)	15 (100%)
Past Surgical History		
Yes	7 (46.7%)	10 (66.7%)
No	8 (53.3%)	5 (33.3%)
Type of Surgical History		
Debridement	1 (6.7%)	1 (6.7%)
Debridement and skin graft	4 (26.7%)	9 (60.0%)
Skin graft	2 (13.3%)	0 (0%)

4.1.3 Anthropometric characteristics of participants in both groups.

Table 4.3: Illustrates the differences between physical characteristics of subjects in both experimental and control groups. Independent t-test indicated no significant differences in age (p=1.00), height (p=0.835), weight (p=0.784), BMI (p=0.624) and the total body surface area (p=0.213). This means both groups have no statistically significant difference in their characteristics.

Table 4.3 ***Physical characteristics of participants in both groups.***

Items	Experimental Group (n=15)		Control Group (n=15)		P-value
	M	SD	M	SD	
Age (years)	11.20	4.784	11.20	4.784	1.0
Height (m)	141.13	21.722	139.47	21.728	.835
Weight (Kg)	41.23	20.272	43.30	20.5651	.784
BMI (Kg/m2)	13.88	4.930	14.81	5.26017	.624
Total Body Surface Area (%)	8.53	3.502	10.93	6.341	.213

Independent t-test
M: Mean SD: Standard deviation.

4.1.4 Normality testing of the continuous data.

Normality Shapiro-Wilk testing for parametric data.

Normality of study variables among the study groups (Experimental and Control) was conducted before starting the data analysis. The test of Kolmogorov-Smirnov Z was used for this purpose, and the following table shows the results of this test:

Table 4.4 ***The results of Kolmogorov-Smirnov Normality Test***

	Kolmogorov-Smirnov[a]			*Shapiro-Wilk*		
	Statistic	*df*	*P-value*	*Statistic*	*df*	*P-value*
Pre.Test.US	.092	30	.200*	.963	30	.365
Pre. Score. MVSS.	.135	30	.172	.972	30	.604

df: degree of freedom.

The results of the normality test in the table above show that most of the study variables among the study groups (experimental, control) were normally distributed since the P-values of the ***Shapiro-Wilk*** test are higher than 0.05 except in (post-score. MVSS).

4.1.5 Inferential statistical analysis of the tested variables.

4.1.5.1. Experimental group before and after testing.

Table 4.5. Shows the paired sample t-test utilized to assess the effectiveness of applying Tubi Grip on the hypertrophic scar thickness among the experimental group. Showed statistically significant improvement as measured by the US, with the pre-test of scar thickness (M=3.26, SD= 1.225) and post-test of scar thickness (M=2.22, SD= 0.892) (p=0.000).

Regarding the **MVSS**, a statistically significant improvement was found between the pre-score of scar thickness (M=2.16, SD= 0.606) and the post-score of scar thickness (M=0.960, SD= 0.406), with an improvement mean of 1.56 mm (P=0.000). This means applying the Tubi Grip on the hypertrophic scar site decreased the scar thickness among subjects in both U/S and MVSS measurements. ***(Table 4.5).***

Table 4.5 ***Table 4.5. US and MVSS in Tubi Grip (experimental group) at the hypertrophic scar site (n=15)***

Measurement's tool		n	Mean	SD	Mean Difference	P-value
U/S	***Pre-test of Scar thickness***	15	3.26	1.225	1.04	.000*
	Post-test of Scar thickness	15	2.22	.892		
MVSS	***Pre-score of Scar thickness***	15	2.16	.606	1.20	.000*
	Post-score of Scar thickness	15	.96	.406		

Paired t-test
N: number SD: standard deviation.
**Significant at the p≤0.05.*

4.1.5.2. Control group before and after testing.

Table 4.6. Shows the paired sample t-test, that was used to assess the effectiveness of applying Garment Pressure on the hypertrophic scar thickness among the control group, as measured by the US, a statistically significant improvement was found between the pre-test of scar thickness (M=3.16, SD= 1.097) and post-test of scar thickness (M=2.30, SD= 1.189). With improvement of 0.86 mm (p=<0.022).

Regarding the MVSS measurement, a statistically significant improvement was found between the pre-score of scar thickness (M=2.16, SD= 0.734) and post-score of scar thickness (M=1.20, SD= 0.679) with the improvement of 0.96 (p=<0.001). This means applying the Garment Pressure Therapy on the hypertrophic scar site affects the scar thickness among subjects in both U/S and MVSS measurements.

Table 4.6 ***Applying the garment pressure (control group) on the hypertrophic scar site (n=15)***

Measurement's tool		n	M	SD	Mean Difference	P-value
U/S	***Pre-test of scar thickness***	15	3.16	1.097	.863	.022*
	Post-test of scar thickness	15	2.30	1.189		
MVSS	***Pre-score of scar thickness***	15	2.16	.734	.96	.001*
	Post-score of scar thickness	15	1.20	.679		

*Paired t-test. *n=number, *M=mean..* SD=standard deviation, *Significant at the p≤0.05*.

4.1.5.3.Difference of mean thickness in between groups, at baseline (before) and follow-up (after) as measured by US and MVSS.

Table 4.7. Shows the independent t-test used to assess the differences between Tubi Grip and Pressure Garments on the hypertrophic scar thickness. An independent t-test was conducted to assess the differences between Tubi Grip (Experimental group) and Pressure Garments (Control group) in terms of pre- and post-test hypertrophic scar thickness using the US measurement tool.

No significant difference was found between the Tubi Grip (M=3.26, SD= 1.225) and Pressure Garment (M=3.16, SD= 1.097) at baseline before the intervention (P=0.522). At the same time, comparing the difference of results at the post-test (follow up), there was no statistically significant difference between the Tubi Grip method (M=2.22, SD=0.892) and Pressure Garment (M=2.30, SD= 1.189) (P=0.454). This means that Tubi grip and garment therapy have led to the same effect on scar thickness using the U/S measurement, with no statistical difference in outcome between the two interventions.

Table 4.7 ***Comparative analysis of scar thickness between two groups of the study (experimental and control) using the US measurement tool***

		group	*n*	*mean mm*	*SD*	*Mean Dif.*	*t value*	*df*	*P-value*
Scar Thickness using the US	**Pre-treatment**	Tubi	**15**	3.26	1.225	0.1	0.235	28	0.522
		Garment pressure	**15**	3.16	1.097				
	Post-treatment	Tubi	**15**	2.22	0.892	- 0.08	0.217	28	0.454
		Garment pressure	**15**	2.3	1.189				

Independent t-test. SD: Standard Deviation; df: degree of freedom.

Table 4.8. Shows the independent t-test that was conducted to assess the differences between tube Grip (Experimental group) and Pressure Garments (Control group) in terms of pre- and post-score hypertrophic scar thickness using the MVSS.

No significant difference was found between the Tubi Grip method group (M=2.166, SD= 0.606) and the Garment Pressure group (M=2.163, SD= 0.734) in terms of pre-score scar thickness (P=0.631).

As well as there was no statistically significant difference between the Tubi Grip group (M=0.960, SD= 0.406) and the Garment Pressure group (M=1.20, SD= 0.679) in terms of post-score scar thickness (P=0.247). This means Tubi grip and garment therapy have the same effect on scar thickness using the MVSS measurement.

Table 4.8 ***Comparative analysis of scar thickness between two groups of the study (experimental & control) using the MVSS measurement tool.***

		group	*n*	*mean mm*	*SD*	*Mean Dif.*	*t value*	*df*	*P-value*
Scar Thickness using the MVSS	**Pre-treatment**	Tubi	**15**	2.16	0.606	0	0.014	28	0.631
		Garment pressure	**15**	2.16	0.734				
	Post-treatment	Tubi	**15**	0.96	0.406	-0.24	-1.206	28	0.247
		Garment pressure	**15**	1.2	0.679				

Independent t-test: SD: Standard Deviation; df: degree of freedom.

4.1.5.4 Correlations between study variables:

Table 4.9. Showed the correlations between age, BMI, degree, improvement in the US.
Using independent sample t-test, there was no statistically significant difference in terms of mean improvement between males, and females (p>0.05)
Using Pearson correlation, there was a statistically significant negative correlation between mean improvement in the US and BMI (the more BMI the less mean improvement). While there was a positive correlation between the mean improvement and pre-scar as measured by the US.

Table 4.9 Pearson correlation between age, BMI, degree, and improvement in the US:

Correlations						
		imp.US	Pre.scar.US	Age	BMI	Degree
imp.US	Pearson Correlation	1	.544**	-0.291	-.475**	-0.07
	Sig. (2-tailed)		0.002	0.119	0.008	0.714
	N	30	30	30	30	30
****. Correlation is significant at the 0.01 level (2-tailed).**						

4.1.5.5 Multivariate Regression:

Running an improvement of scar thickness in US (change between baseline and posttest) regression analysis, with a suggested model of imp.US outcome measure values represented in, and BMI, the following predictor was identified for the improvement in the different outcome measures.

4.1.5.6 Scar thickness improvement in the US:

As shown below in table 4.10 the regression model indicates that 0.47of the scar thickness improvement variation is explained by the below regression model (R2 = 0. 225). (P =.008), the variation in the scar thickness improvement is predicted significantly by 1 independent variable,

BMI (B= -.095). Which means that the decrease in BMI will increase the improvement in scar thickness with a percentage (R^2 = 22.5%).

Table 4.10 Multivariate Regression of scar thickness improvement in the US.

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-Value
		B	Std. Error	Beta		
1	(Constant)	2.318	.505		4.590	.000
	BMI	-.095	.033	-.475	-2.854	.008

a. Dependent Variable: imp.US

Table 4.11 Multivariate Regression analysis of scar thickness improvement in the US.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.475[a]	.225	.198	.90141	.225	8.148	1	28	.008

a. Predictors: (Constant), BMI b. Dependent Variable: imp.US

Table 4.12 ANOVA test of the suggested model

ANOVA

Model		Sum of Squares	df	Mean Square	F	P-Value
1	Regression	6.621	1	6.621	8.148	.008[b]
	Residual	22.751	28	.813		
	Total	29.372	29			

a. Dependent Variable: imp.US

b. Predictors: (Constant), BMI

Table 4.13: Showed the correlations between age, BMI, degree, and improvement in MVSS.

Using independent sample t-test, there was no statistically significant difference in terms of mean improvement between males, and females ($p>0.05$)

Using Pearson correlation, there was a statistically significant positive correlation between mean improvement in MVSS and BMI (the more BMI the mean improvement). While there was a positive correlation between the mean improvement and pre scar as measured by MVSS.

Table 4.13 Pearson correlation between age, BMI, degree, and improvement in MVSS:

Correlations					
		imp. MVSS	Age	BMI	Degree
imp. MVSS	Pearson Correlation	1	.276	.460*	.120
	Sig. (2-tailed)		.140	.011	.527
	N	30	30	30	30
***. Correlation is significant at the 0.05 level (2-tailed).**					
****. Correlation is significant at the 0.01 level (2-tailed).**					

Table 4.14 Multivariate Regression analysis of scar thickness improvement in the MVSS.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.460[a]	.211	.183	.66301	.211	7.505	1	28	.011

a. Predictors: (Constant), BMI b. Dependent Variable: imp. MVSS

Table 4.15 ANOVA test of the suggested model

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	P-Value
1	Regression	3.299	1	3.299	7.505	.011[b]
	Residual	12.308	28	.440		
	Total	15.607	29			

a. Dependent Variable: imp. MVSS b. Predictors: (Constant), BMI

Table 4.16 Coefficients of the predictors

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-Value
		B	Std. Error	Beta		
1	(Constant)	-2.044	.371		-5.502	.000
	BMI	.067	.024	.460	2.739	.011

a. Dependent Variable: imp. MVSS

4.2 Discussion

Post-burn hypertrophic scars are still a substantial challenge to both patients and health care professionals working with burn survivors, which affect patients' lifestyles, quality of life, and psychology. Hypertrophic scars prevention and rehabilitation is an important health concern. (Tawfik, et al., 2018).

Therefore, the intended purpose of this study was to examine and compare the efficiency of Tupi grip versus pressure garments in the management of post-burn hypertrophic scars and investigate the factors that influence the prognosis of hypertrophic scars post-burn.

The mean age of the experimental and control group was not statistically different between the two groups, as in both groups the age was within the range of the inclusion criteria that were between 06-18 years old. The choice of these age boundaries was associated with the fact that children are more vulnerable to burns, particularly when compared to adults. Burn is the fifth most common cause of non-fatal childhood injuries among children living in low- and middle-income countries of the WHO Eastern Mediterranean Region, they are almost two times as likely to injury from burns as compared to boys who are living in the European Region (WHO, 2018). Regarding the Palestinian Ministry of Health (Health Information System HIS), the patients, who they admitted to the burn unit at Rafedia Governmental Hospital for intervention were 257 patients, 182 were children as a percentage of 70% from the total number of patients, in the year 2020. With comparing to the year 2021, 146 were children as a percentage of 59%, from the total number that were 247 of burned patients, who they required intervention in the burn unit(https://www.moh.gov.ps).

In terms of gender females constitute the highest proportion in the experimental group (53.3%), while the control group female was (40.0 %), previous studies showed that gender is a significant risk factor for burn, where females are at higher risk rates of death from burns than males, due to the more household activities that females are exposed to in cooking, or inherently unsafe cookstoves. In addition to, heating is a major factor (Qtait, 2019).

In terms of patient's weight as represented by BMI, in general, it showed that the participants were slightly underweight in both the experimental and control groups, 73.3% of both groups were underweight.

Obesity is a risk factor that indicates to be a well-known metabolic disease, and it may delay skin healing due to the risk of multifactorial specific challenges, such as fluid resuscitation, acceptable hypermetabolic reaction, related to burn pathophysiology of burns, when compared to normal-weight patients, so obese patients have few challenges in certain management options like the surgical treatment, fluid resuscitation, and wound healing difficulties and this will affect in the progressive of increasing hypertrophic scar (Houschyar et al., 2019). They concluded that the effect in burn care will progressively increase with the prevalence of obesity, and the complications of Obesity may influence the treatment in acute and long-term burn management. The researchers are recommending, future research is required and must take into consideration the characteristics post-burn to identify the effect of BMI on the post-burn hypertrophic scar, to consent to therapy based on scientific evidence.

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In terms of the patient's degree of burn, second-degree burns constituted the majority in both experimental 13 (86.7%) and control groups 11 (73.3%); this finding is consistent with the finding of another Palestinian study (Qtait, 2019); they studied the files of the emergency

department in two years 2016 and 2017. They showed that children under 14 years old, females, incidents occurring in winter, and scald burns should receive more attention to prevent burn injuries. They concluded that Scalding was found to be the most important cause of burns and most in burn Palestinian people would reduce burn injuries among children. The reason why second-degree burn was the highest proportion is related to children's behaviors that are linked to scalding burn due to hot fluids and drinks, and hot oil.

Concerning the **effectiveness of the Tubi grip** (experimental group), there was a statistically significant difference between pre- and post-intervention as measured by the US (1.04 mm improvement ($p < 0.05$). The same results were also found when it was measured by MVSS, as there was a statistically significant difference between MVSS pre and post-test 1.20mm improvement ($P < 0.05$). This finding is similar to the results found by (Rose & Deitch, 1983), who studied the clinical use of a tubular compression bandage (Tubi grip) in 23 pediatric burn patients. Twelve of the children (52%) were under age three years, and the mean TBSA burn was 23% (range 3% to 70%). They concluded that Tubi grip is most effective on the flat circumferential areas, including upper and lower extremities, and it has added a new therapeutic dimension to traditional compression methods in selected pediatric burn patients.

In terms of the **effectiveness of the pressure garment** (control group), there was a statistically significant difference between pre- and post-intervention as measured by the US (0.86mm improvement ($p<0.05$). The same results were also found when it was measured by MVSS, as there was a statistically significant difference between MVSS pre and post-test (0.96mm improvement ($p < 0.05$). This means that using pressure garments are effective in reducing hypertrophic scar post-burn. These findings support the results found by the study of (Kim et al., 2015), they concluded that Pressure garments therapy significantly hindered the scar contraction

when they were compared to control scars, and significantly reduced skin hardness. They concluded that pressure garment therapy was effective in reducing scar contraction and improving biomechanics compared to control scars.

Concerning the difference of improvement (between groups) there was no statistically significant difference in US post-tests in between the Tubi Grip, and the pressure garments (-0.08mm, and p-value 0.522) ($p>0.05$). The same results were confirmed when we compared the difference of post-tests as measured by the MVSS, where there was no statistically significant difference between the two groups in the posttest of MVSS outcome measure ($p>0.05$) in between the two groups. This could be due to the small sample size, and the short period of intervention which was around 8 weeks. This finding is consistent with the results of a prospective randomized study that was comparing two types of pressure therapy garments. One hundred ten patients were enrolled, where 54 patients received pressure garments, and 56 received Tubi grip pressure garments. They concluded that the Tubi grip garments' treatment cost was lower significantly than the other group, they recommended using elasticized cotton pressure garments (Tubi grip) at a lower cost with identical therapeutic efficacy when compared to the nylon expensive pressure garments (Kealey, et al., 1990). These findings also are similar to the results of (Rose & Deitch, 1983), whom they have concluded that the Tubi grip is more effective on the upper and lower extremities and that it has added a new therapeutic approach to traditional compression methods in selected pediatric burn patients.

The study findings identified that cheap Tubi grip and very expensive pressure garments have the same efficacy in decreasing post-burn scar thickness. This means that physical therapists can

promote the use of high cost-effective treatment of Tubi grip, instead of the pressure garments, since they have the same results, with a high difference of price in between cheap Tubi grip and the very expensive pressure garments. This conclusion is recommended to be educated and distributed among physiotherapists in Palestine working with burns rehabilitation, where we are kept to use highly effective and affordable tools of rehabilitation, that can lead to better outcomes, with the least costs, especially that we are talking about the scarcity of resources within the Palestinian Ministry of Health.

These findings also need to be communicated on the level of practitioners, and policy makers of rehabilitation in the ministry of health, where the use of affordable and effective Tubi grip should be promoted with the aim of achieving a functional scar in post burn rehabilitation.

In terms of Pearson correlation, there was a statistically significant negative Pearson correlation (r= -,475, p-value = 0.008), between mean improvement in the ultrasound and BMI; which means that increased BMI, will lead to less improvement of the post-burn hypertrophic scar as measured by ultrasound. In the multivariate regression analysis, this negative association between BMI and thickness was underlined, where BMI was the only predictor of the thickness of the post-burn scar. The current study finding is consistent with the study results of (Houschyar et al., 2019). They concluded that the effect of Obesity may influence the treatment of burns in acute and long-term management. The researchers recommended that future research is necessary and must take into consideration the characteristics of post-burn, to identify the effect of BMI on the post-burn hypertrophic scar, to consent to therapy based on scientific evidence.

Whereas, in terms of Pearson correlation between the improvement in MVSS and the independent predictor BMI on the effect of reducing hypertrophic scar, the study showed a statistically significant positive correlation (r= .460, p-value 0.011), between mean improvement (decreased thickness) in MVSS and BMI. This means that increased BMI decreases the scar thickness when measured by MVSS. This relation was also confirmed by the multivariate regression analysis, which has identified the positive effect of BMI on improvement outcome of the pressure therapy on post-burn hypertrophic scar patients, as BMI was also the only statistically significant independent predictor of Scar thickness as measured by MVSS.

This variation of the direction of the relation of BMI, in the two cases (US Vs MVSS). May be justified by the fact that the US measures the superficial scar thickness, the fibroid tissues, and adhesions reaching the dermal layer; while the MVSS measures, only the superficial hypertrophic scar, Tubi Grip and GPT, both techniques are imposing pressure on hypertrophic scar, the imposed pressure is the reason why MVSS showed an improvement when measuring hypertrophic scar thickness. The results of this study were confirmed by the results of (Lee et al., 2019), the author aimed to evaluate 55 scar and normal skin sites using subjective Modified Vancouver Scar Scale (MVSS), Patient and Observer Scar Assessment Scale (POSAS) and objective tools by independent assessors. Who concluded that the objective scar measures demonstrated excellent reliability and accuracy compared with the subjective scar scales. These findings were also supported by (Ud-Din & Bayat, 2022), who recommended further investigations, regarding a potential tool, that can play as a predictor for the accuracy of scar thickness evaluation, that allows early implementation of therapy, diagnosis, and prognosis of the hypertrophic scar post-burn. This issue is also representing a baseline for future research, investigating the possibilities of using

further technology in a more accurate assessment of the thickness of post-burn scar that represents the best outcome measure for post-burn rehabilitation outcome.

4.3 Study Limitations

- The researcher identified several limitations of this study, that future researchers are recommended to take into consideration in any further research a bigger sample size, and a longer period of follow up and treatment, that can reach up to 6 months, to be able to identify the ultimate effect of the used interventions, and Limited sources of literature related to our study. Other limitation of this study is that it was conducted at the peak period of COVID 19, and its restrictions may have affected the implementation period.

Chapter Five

Conclusion and recommendations

5.1 Conclusion

This study has highlighted the effectiveness of two methods of intervention in post-burn scar management and has identified that both techniques were effective with no difference of rehabilitation outcome, represented in scar thicknesses as measured by both US and MVSS. With no significant difference in the outcome of either of the two methods. The Tubi grip is found to be a very cost-effective method of post-burn-scar thickness rehabilitation outcome.

5.2 Recommendations

Given the results of this study, the researcher recommends the following:

For Health policymakers and physiotherapists:

Additional training and lectures for physiotherapists should be given in hospitals to increase their knowledge about pressure garments and Tubi grip efficacy application and the importance of adherence.

- Health policymakers should advise physiotherapists to utilize Tubi grip to become a major part of the post-burn management protocol.
- The necessity of implementing burn preventive health programs, particularly among high-risk vulnerable groups to burn.
- Cost-effective Tubi grip method to be adopted by the MOH, to decrease the health expenditure on the government for post-burn treatments.
- To incorporate the use of this method in the higher education curriculum

***For future Research*:**

- Making a comprehensive database for each post-burn case within the MOH burn units, to help in further future research in this field.
- To adopt a longer period of intervention in future research, which would allow for a better understanding of the long-term outcome of using the Tubi grip.
- Further research to develop a more accurate objective tool for measuring post-burn hypertrophic scar.
- Future research to identify the influence of BMI on the improvement of thickness of hypertrophic scar post- burn.

Appendix 1

Consent form

Arabic version

نموذج موافقة على المشاركة في دراسة

عزيزيالمشارك/ المشاركة

تهدف هذه الدراسة إلى البحث في **تجربة** العلاج ما بعد الحروق باستخدام التقنية الضغط باستخدام المشدات االمراجعين فيمستشفى رفيديا الجراحي الحكومي \ قسم العلاج الطبيعي للتعرف على مدى فاعلية اداء هاتين التقنيتين في التقليل من تضخم الندبة ما بعد الحرق.

المشاركة طوعيه وستستعمل لأغراض الدراسة فقط ولن يطلع عليها أحد من غير الباحثين ولن يكون هناك اي اشاره الى هويه المشارك والمعلومات ستعامل بسرية. ولن يكون هناك تبعات غير ذلك.

لقد تم توضيح كل النقاط السابقة الذكر لي وبشكل مفصل. وتمت الاجابة على كل اسئلتي. وفهمت ان لي الحق بطرح أي سؤال حول الدراسة في أي وقت كان. وان هذه الاسئلة ستجاب من خلال الباحث الرئيسي.

بتوقيعي على هذا النموذج، اوافق على المشاركة في هذه الدراسة البحثية.

الاسم :.....
العمر:.....

توقيع المشارك (ولي الامر) :----------

توقيع الباحـــــــــث ----------

التاريخ:----------

Appendix 2

Patient First Interview Guide
English version

REF.: ---------- ***Group: A B***

Demographic data	*Pre-test measure*	*Post-test measure*
▪ Clinic Name:		
▪ Name:		
▪ Age: ▪ Gender: ▪ Occupation: ▪ Height: ▪ Weight: ▪ BMI: ▪ Incidence of BMI: ▪ Cause of burn Degree of burn : Site of burn: ▪ Total body surface area.		
▪ Past medical history:		
▪ Past surgical history:		
▪ History of trauma or any other neurological deficits:		
▪ Scar thickness by using Ultrasonography:		
▪ Scar thickness by using Modified Vancouver Scar Scale:	**Pigmentation=** **Vascularization=** **Pliability=** **Height=** **Scoring=**	**Pigmentation=** **Vascularization=** **Pliability=** **Height=** **Scoring=**

Appendix 3

Modified Vancouver Scar Scale	
Pigmentation	0 normal 1 hypopigmentation 2 hyperpmenation
Vascularization	0 normal skin 1 pink slight increase in local blood supply 2 red significant slight increase in local blood supply 3 purple receive local blood sypply
Pliability	0 normal 1 Supple: offers slight resistance 2 Yielding: gives way to pressure 3 Firm: not easily stretched, moves as a whole 4 Banding: scar retraction that blanches when stretched but does not limit the range of motion 5 Contracture: scar retraction that limits the range of motion
Height	0 Normal 1 < 2MM 2 > 2MM < 5 MM 3 > 5 MM

- **Categories for the modified Vancouver scale are (<5: best, 5–10: worse, >10: more worse).**

Appendix 4

Al-Quds University
Jerusalem
Deanship of Scientific Research

جـامـعـة الـقـدس
القدس
عمادة البحث العلمي

Research Ethics Committee
Committee's Decision Letter

Date: March 27, 2021
Ref No: 180/REC/2021

Dear Dr. Akram Amro, Mr. Mohanad Ali,

Thank you for submitting your application for research ethics approval. After reviewing your application entitled "The Effectiveness of Tubi Grip Vs. Pressure Garment in the Rehabilitation Program of Post- Burn Hypertrophic Scar", the Research Ethics Committee confirms that your application is in accordance with the research ethics guidelines at Al-Quds University.

We would appreciate receiving a copy of your final research report/ publication.

Thank you again and wish you a productive research that serves the best interests of your subjects.

PS: This letter will be valid for two years.

Sincerely,

Suheir Ereqat, PhD
Associate Professor of Molecular Biology

Research Ethics Committee Chair

Cc. Prof. Imad Abu Kishek - President
Cc. Members of the committee
Cc. file

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References

Herndon, D. N. (2018). *Total burn care*. Elsevier Health Sciences.

Jump up to:[a b c d e f g h] "Burns". World Health Organization. September 2016. Archived from the original on 21 July2017. Retrieved 1 August 2017.

Jump up to:[a b c d e f g h i j k l m n o p q] Granger J (January 2009). "An Evidence-Based Approach to Pediatric Burns". Pediatric Emergency Medicine

JA, G.-E., Aguilar-Aragon, V. B., Ortiz-Villalobos, E. H., Garcia-Manzano, R. A., & Antonio, B. A. (2017). *General Medicine: Open Access*.

Ai, J.-W., Zeng, X.-T., Liu, Y., Fu, Y., Liu, T.-Z., & Pei, B. (2016). Association between angiotensin converting enzyme gene insertion/deletion polymorphism and renal scar risk in children vesicoureteral reflex: a reappraise meta-analysis. *Scientific Reports*, *6*(1), 1–9.

World health organization (WHO, 2018). Burn fact sheet. https://www.who.int/news-room/fact-Sheets/detail/burns.

Bloemen, M. C. T., van der Veer, W. M., Ulrich, M. M. W., van Zuijlen, P. P. M., Niessen, F. B., & Middelkoop, E. (2009). Prevention and curative management of hypertrophic scar formation. *Burns*, *35*(4), 463–475.

Brockes, J. P., Kumar, A., & Velloso, C. P. (2001). Regeneration as an evolutionary variable. *The Journal of Anatomy*, *199*(1–2), 3–11.

Su CW, Alizadeh K, Boddie A, Lee RC. The problem scar. Clin Plast Surg. 1998 Jul;25(3):451-65. PMID: 9696905.

Mustoe TA, Cooter RD, Gold MH, Hobbs FD, Ramelet AA, Shakespeare PG, Stella M, Téot L, Wood FM, Ziegler UE; International Advisory Panel on Scar Management. International clinical recommendations on scar management. Plast Reconstr Surg. 2002 Aug;110(2):560-71. doi: 10.1097/00006534-200208000-00031. PMID: 12142678.

Gold, M. H., Berman, B., Clementoni, M. T., Gauglitz, G. G., Nahai, F., & Murcia, C. (2014).

Updated international clinical recommendations on scar management: part 1—evaluating the evidence. *Dermatologic Surgery*, *40*(8), 817–824.

Chang CW, Ries WR. Nonoperative techniques for scar management and revision. Facial Plast Surg. 2001 Nov;17(4):283-8. doi: 10.1055/s-2001-18826. PMID: 11735062.

Steinstraesser, L., Flak, E., Witte, B., Ring, A., Tilkorn, D., Hauser, J., Langer, S., Steinau, H.-U., & Al-Benna, S. (2011). Pressure garment therapy alone and in combination with silicone for the prevention of hypertrophic scarring: randomized controlled trial with intraindividual comparison. *Plastic and Reconstructive Surgery*, *128*(4), 306e-313e.

Atiyeh, B. S., El Khatib, A. M., & Dibo, S. A. (2013). Pressure garment therapy (PGT) of burn scars: evidence-based efficacy. *Annals of Burns and Fire Disasters*, *26*(4), 205.

Mangano, A. (2011). Topical silicone gel versus placebo in promoting the maturation of burn scars: a randomized controlled trial—the pivotal role of statistics. *Plastic and Reconstructive Surgery*, *128*(2), 607.

Esselman, P. C. (2007). Burn rehabilitation: an overview. *Archives of Physical Medicine and Rehabilitation*, *88*(12), S3–S6.

Capek, K. D., Hughes, B. D., & Warden, G. D. (2018). Functional sequelae and disability assessment. In *Total burn care* (pp. 673–678). Elsevier.

Van Zuijlen, P. P., Angeles, A. P., Kreis, R. W., Bos, K. E., & Middelkoop, E. (2002). Scar assessment tools: implications for current research. *Plastic and Reconstructive Surgery*, *109*(3), 1108–1122.

Richard, R., Baryza, M. J., Carr, J. A., Dewey, W. S., Dougherty, M. E., Forbes-Duchart, L., Franzen, B. J., Healey, T., Lester, M. E., & Li, S. K. F. (2009). Burn rehabilitation and research: proceedings of a consensus summit. *Journal of Burn Care & Research*, *30*(4), 543–573.

Coghlan, N. (2019). The experience of wearing compression garments post-burn injury: A

qualitative study of patient perspectives and recommendations for practice.

Ladak, A., & Tredget, E. E. (2009). Pathophysiology and management of the burn scar. Clinics in Plastic Surgery, 36(4), 661–674.

Tredget, E. E., Levi, B., & Donelan, M. B. (2014). Biology and principles of scar management and burn reconstruction. Surgical Clinics, 94(4), 793–815.

Organization, W. H. (2007). *International Classification of Functioning, Disability, and Health: Children & Youth Version: ICF-CY*. World Health Organization.

Chang, L.-W., Deng, W.-P., Yeong, E.-K., Wu, C.-Y., & Yeh, S.-W. (2008). Pressure effects on the growth of human scar fibroblasts. *Journal of Burn Care & Research*, *29*(5), 835–841.

Anthonissen, M., Daly, D., Janssens, T., & Van den Kerckhove, E. (2016). The effects of conservative treatments on burn scars: a systematic review. *Burns*, *42*(3), 508–518.

Sliwa, J. A., Heinemann, A., & Semik, P. (2005). Inpatient rehabilitation following burn injury: patient demographics and functional outcomes. *Archives of Physical Medicine and Rehabilitation*, *86*(10), 1920–1923.

Chapman, T. T. (2007). Burn scar and contracture management. *Journal of Trauma and Acute Care Surgery*, *62*(6), S8.

Fauerbach, J. A., Lezotte, D., Hills, R. A., Cromes, G. F., Kowalske, K., De Lateur, B. J., Goodwin, C. W., Blakeney, P., Herndon, D. N., & Wiechman, S. A. (2005). The 2004 Clinical Research Award: burden of burn: a norm-based inquiry into the influence of burn size and distress on recovery of physical and psychosocial function. *The Journal of Burn Care & Rehabilitation*, *26*(1), 21–32.

Pallua, N., Künsebeck, H. W., & Noah, E. M. (2003). Psychosocial adjustments 5 years after burn injury. *Burns*, *29*(2), 143–152.

Ganio, M. S., Gagnon, D., Stapleton, J., Crandall, C. G., & Kenny, G. P. (2013). Effect of human skin grafts on whole-body heat loss during exercise heat stress: a case report. *Journal of Burn Care & Research*, *34*(4), e263–e270.

Richard, R., Baryza, M. J., Carr, J. A., Dewey, W. S., Dougherty, M. E., Forbes-Duchart, L., Franzen, B. J., Healey, T., Lester, M. E., & Li, S. K. F. (2009). Burn rehabilitation and research: proceedings of a consensus summit. *Journal of Burn Care & Research*, *30*(4), 543–573.

Casaer, M., Kums, V., Wouters, P. J., & Van den Berghe, G. (2008). Pruritus in patients with small burn injuries. *Burns*, *34*(2), 185–191.

Macintyre, L., & Baird, M. (2006). Pressure garments for use in the treatment of hypertrophic scars—a review of the problems associated with their use. *Burns*, *32*(1), 10–15.

Ogawa, R. (2010). The most current algorithms for the treatment and prevention of hypertrophic scars and keloids. *Plastic and Reconstructive Surgery*, *125*(2), 557–568.

Esselman, P. C. (2007). Burn rehabilitation: an overview. *Archives of Physical Medicine and Rehabilitation*, *88*(12), S3–S6.

Van den Kerckhove, E., Stappaerts, K., Fieuws, S., Laperre, J., Massage, P., Flour, M., & Boeckx, W. (2005). The assessment of erythema and thickness on burn related scars during pressure garment therapy as a preventive measure for hypertrophic scarring. *Burns*, *31*(6), 696–702.

Chapman, T. T. (2007). Burn scar and contracture management. *Journal of Trauma and Acute Care Surgery*, *62*(6), S8.

Sharp, P. A., Pan, B., Yakuboff, K. P., & Rothchild, D. (2016). Development of a best evidence statement for the use of pressure therapy for management of hypertrophic scarring. *Journal of Burn Care & Research*, *37*(4), 255–264.

Rose, M. P., & Deitch, E. A. (1983). Rehabilitation: The Effective Use of a Tubular Compression Bandage; Tubigrip; for Burn Scar Therapy in the Growing Child. *The Journal of Burn Care & Rehabilitation*, *4*(3), 197–201.

Kealey, G. P., Jensen, K. L., Laubenthal, K. N., & Lewis, R. W. (1990). Prospective randomized comparison of two types of pressure therapy garments. *The Journal of Burn Care &*

Rehabilitation, *11*(4), 334–336.

Tawfik, A. M., Othman, E. M., Kenawy, A. M., & AboElnour, N. H. (n.d.). *Effectiveness of Kinesio Taping Versus Deep Friction Massage on Post Burn Hypertrophic Scar*.

Candy, L. H. Y., Cecilia, L.-T. W. P., & Ping, Z. Y. (2010). Effect of different pressure magnitudes on hypertrophic scar in a Chinese population. *Burns*, *36*(8), 1234–1241.

Kim, J. Y., Willard, J. J., Supp, D. M., Roy, S., Gordillo, G. M., Sen, C. K., & Powell, H. M. (2015). Burn scar biomechanics following pressure garment therapy. *Plastic and Reconstructive Surgery*, *136*(3), 572.

Li, P., Li-Tsang, C. W. P., Deng, X., Wang, X., Wang, H., Zhang, Y., Tan, Z., & He, C. (2018). The recovery of post-burn hypertrophic scar in a monitored pressure therapy intervention programme and the timing of intervention. *Burns*, *44*(6), 1451–1467.

Houschyar, K. S., Tapking, C., Borrelli, M. R., Popp, D., Duscher, D., Maan, Z. N., Chelliah, M. P., Li, J., Harati, K., & Wallner, C. (2019). Wnt pathway in bone repair and regeneration–what do we know so far. *Frontiers in Cell and Developmental Biology*, *6*, 170.

DeBruler, D. M., Baumann, M. E., Blackstone, B. N., Zbinden, J. C., McFarland, K. L., Bailey, J. K., Supp, D. M., & Powell, H. M. (2019). Role of early application of pressure garments following burn injury and autografting. *Plastic and Reconstructive Surgery*, *143*(2), 310e-321e.

Mohammed, I. R., & Abolwafa, N. F. (2019). Using Pressure Garment versus Hospital Routine Care on Reducing Scars Immediately after Burn Surgery. *American Journal of Nursing*, *7*(3), 269–277.

Lee, K. C., Bamford, A., Gardiner, F., Agovino, A., Ter Horst, B., Bishop, J., Sitch, A., Grover, L., Logan, A., & Moiemen, N. S. (2019). Investigating the intra-and inter-rater reliability of a panel of subjective and objective burn scar measurement tools. *Burns*, *45*(6), 1311–1324.

Das, D., Yadav, N., & Arora, E. (2020). Study on the effect of combined action of topical silicone gel and pressure therapy in hypertrophic scar management. *International Surgery*

Journal, *7*(6), 1817–1820.

Elrefaie, A. M., Salem, R. M., & Faheem, M. H. (2020). High-resolution ultrasound for keloids and hypertrophic scar assessment. *Lasers in Medical Science*, *35*(2), 379–385.

Tsai, W.-Y., Hsueh, Y.-Y., Chen, P.-Y., Hung, K.-S., & Huang, C.-C. (2022). High-Frequency Ultrasound Elastography for Assessing Elastic Properties of Skin and Scars. *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, 1. https://doi.org/10.1109/TUFFC.2022.3154235

Ud-Din, S., & Bayat, A. (2022). Noninvasive Objective Tools for Quantitative Assessment of Skin Scarring. *Advances in Wound Care*, *11*(3), 132–149.

Qtait, M. T. (2019). Alekel k (2019) Prevalence and Epidemiological of Burns in Hebron, Palestine. *Sch J Appl Sci Res*, *2*, 6–10.

Singh, J., & Chaturvedi, S. (2016). *IIT JEE Physics*.

Muteti, E. N., & ElBadawi, M. G. Y. (2018). Reliability of vernier caliper measurements of the thoracic pedicle transverse diameter. *Anatomy Journal of Africa*, *7*(2), 1232–1237.

Iraniha, S., Cinat, M. E., VanderKam, V. M., Boyko, A., Lee, D., Jones, J., & Achauer, B. M. (2000). Determination of burn depth with noncontact ultrasonography. *The Journal of Burn Care & Rehabilitation*, *21*(4), 333–338.

Thompson, C. M., Sood, R. F., Honari, S., Carrougher, G. J., & Gibran, N. S. (2015). What score on the Vancouver Scar Scale constitutes a hypertrophic scar? Results from a survey of North American burn-care providers. *Burns*, *41*(7), 1442–1448.

Esselman PC, Thombs BD, Magyar-Russell G, Fauerbach JA. Burn rehabilitation: state of the science. Am J Phys Med Rehabil. 2006 Apr;85(4):383-413. doi: 10.1097/01.phm.0000202095. 51037.a3. PMID: 16554686.

Harries, C. A., & Pegg, S. P. (1989). Measuring pressure under burns pressure garments using the Oxford Pressure Monitor. *Burns*, *15*(3), 187–189.

Mehta, S., Coffey, R., Jones, L. M., Powell, H. M., & Bailey, J. K. (2019). Survey of national

and local practice of compression therapy timing for burn patients in the United States. *Burns*, *45*(5), 1215–1222.

Moore, T. E., Giles, B. L., Delcourt, D. C., & Fok, M.-C. (2000). The plasma sheet source groove. *Journal of Atmospheric and Solar-Terrestrial Physics*, *62*(6), 505–512.

Statewide *Burn* Injury Service – *Burn Physiotherapy and Occupational Therapy Guidelines*. Page ii. AGENCY FOR ... Agency for Clinical Innovation *2017.*

Palestinian Ministry of Health (health information system HIS) (2021). (https://www.moh.gov.ps).