

Cutaneous Scar Prevention and Management

Overview of current therapies

*Sultan Al-Shaqsi and Taimoor Al-Bulushi

الوقاية من الندب الجلدية وعلاجها نظرة عامة على العلاجات المستخدمة حالياً

سلطان الشقسي و تيمور البلوشي

ABSTRACT: Cutaneous scarring is common after trauma, surgery and infection and occurs when normal skin tissue is replaced by fibroblastic tissue during the healing process. The pathophysiology of scar formation is not yet fully understood, although the degree of tension across the wound edges and the speed of cell growth are believed to play central roles. Prevention of scars is essential and can be achieved by attention to surgical techniques and the use of measures to reduce cell growth. Grading and classifying scars is important to determine available treatment strategies. This article presents an overview of the current therapies available for the prevention and treatment of scars. It is intended to be a practical guide for surgeons and other health professionals involved with and interested in scar management.

Keywords: Scarring; Hypertrophy; Keloids; Silicone; Steroids; Surgery.

المخلص: تشيع الندب الجلدية بعد حالات الرضخ أو الجراحة أو العدوى. وتحدث عندما تستبدل أنسجة الجسم الطبيعية بأنسجة أرومية ليفية أثناء عملية الالتئام. وإلى الآن لا تزال الفيزيولوجيا المرضية لعملية تكوين الندب غير مفهومة بصورة تامة. إلا أنه من المعروف أن لدرجة التوتر عبر أطراف الجرح، وسرعة نمو الخلايا دوراً مهماً في هذه العملية. من الضروري الوقاية من الندب، ويتم هذا بالانتباه إلى الطرق الجراحية المستخدمة، وباستخدام الوسائل المناسبة للتقليل من نمو الخلايا. ومن المهم معرفة الندب بحسب درجتها وتصنيفها كي تحدد لها الاستراتيجيات العلاجية المتوفرة. نقدم في هذا المقال نظرة عامة للعلاجات المتوفرة حالياً للوقاية والعلاج من الندب، لاستخدامه كدليل عملي للجراحين والمهنيين الآخرين في مجال الصحة من العاملين في الوقاية من الندب وعلاجها، أو من الراغبين معرفة المزيد في هذا الموضوع.

مفتاح الكلمات: تكوين الندب؛ تضخم؛ جدرات؛ سيليكون؛ استيرويدات؛ جراحة.

EVERY PHYSICAL INJURY TO THE HUMAN skin leaves a footprint in the form of a scar which can range in appearance from hardly visible to extensively disfiguring. Cutaneous scars commonly form after surgical operations, trauma, burns and infections. It is estimated that approximately 100 million people develop scars after trauma and elective surgery in middle-income countries every year.^{1,2} Furthermore, 15% of this population will require surgical intervention for their scars due to aesthetic considerations or functional impairment.²

Scars can have disturbing physical, aesthetic, functional, psychological and social connotations.³ Physical symptoms frequently reported by sufferers of excessive scarring include uncontrollable pruritus, stiffness, scar contracture and pain while the psychological consequences include diminished self-esteem and confidence and increased stigmatisation and mental suffering (e.g. anxiety and depression). Several societies use unique scars as a permanent

marker for low social status.¹ For example, in ancient Arab cultures, scars around the tip of the nose of a man indicated that he had been defeated in war.⁴ Studies have shown that the physical appearance of a surgical scar following elective surgery is strongly associated with patient satisfaction; one study found that 95% of patients who underwent elective surgery described their overall healthcare experience based on the physical appearance of their surgical scar.^{5,6} Therefore, a good understanding of scar prevention and management is relevant to many areas of medical practice. This review provides a practical flowchart for scar prevention and discusses management guidelines based on recent international recommendations published by the International Advisory Panel of Scar Management (IAPSM).^{1,2,7} Along with recommendations for scar prevention and management, this article highlights emerging and future strategies in the treatment of scars.

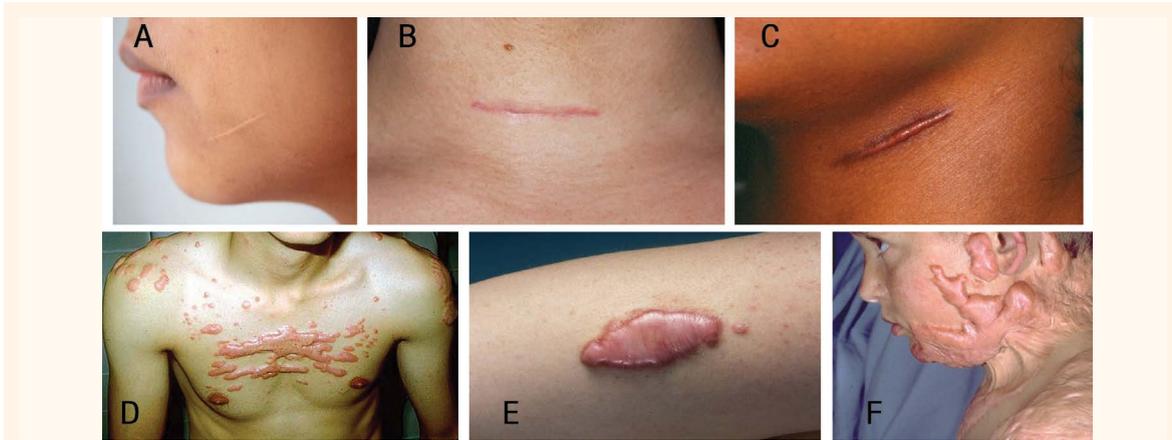


Figure 1 A–F: Photographs of a (A) mature scar, (B) immature scar, (C) linear hypertrophic scar, (D) widespread hypertrophic scar, (E) minor keloid and (F) major keloid.

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Scar Formation

A scar is the fibroblastic replacement of normal skin tissue that has healed by resolution rather than regeneration. The degree of scarring is determined by the extent of the initial wound and the time interval between the injury and complete healing. Several factors contribute to the formation of scars, including infections, retention of foreign bodies and prolonged healing beyond 2–3 weeks.^{1–4} Normal skin has a matrix of collagen sheets, while scars have organised unidirectional collagen bundles. This leads to prominent or raised tissue in comparison to normal skin.

TYPES OF SCARS

Clinically significant scars are divided into two categories: hypertrophic or keloid [Figure 1]. Hypertrophic scars are defined as excessive tissue production at the site of a physical injury to the skin which remains within the boundaries of the initial lesion.¹ These can be subdivided into linear or widespread hypertrophic

scars. Linear scars usually result from surgery or localised trauma while widespread hypertrophic scars can be a consequence of extensive burns or soft tissue infections.¹ Unlike hypertrophic scars, keloids involve excessive scarring that extends beyond the boundaries of the initial lesion. They have a low chance of regression and a high chance of recurrence after treatment.¹ Keloids are described as minor if the scar extends less than 0.5 cm beyond the border of the initial lesion or major if the scar extends more than 0.5 cm beyond the border.¹ There are several histological differences between hypertrophic and keloid scars on a cellular level. For instance, hypertrophic scars contain well organised type III collagen fibres while keloids contain a disarray of type I and III collagen bundles.⁵

Scar Prevention

Prevention of scars is critical as it is much easier to prevent formation than to rely on management once

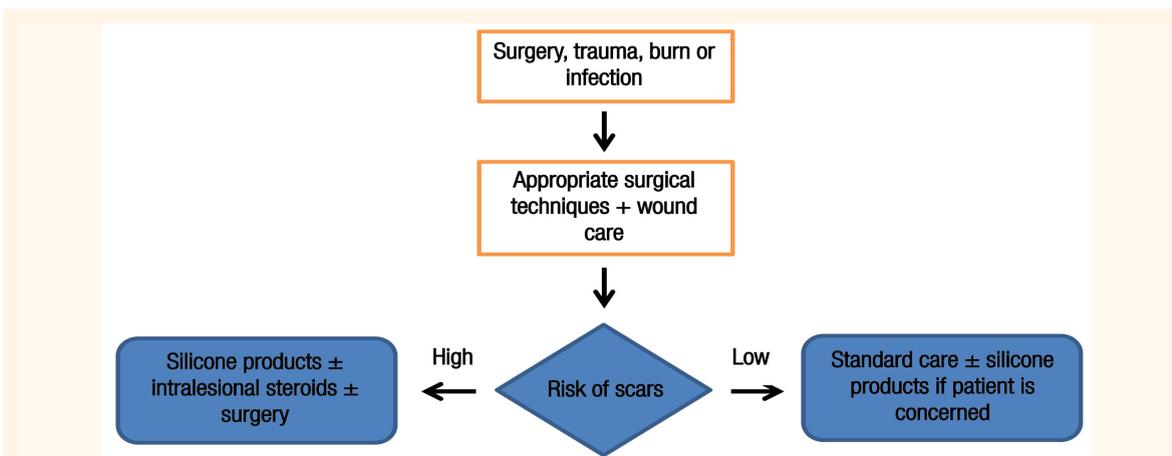


Figure 2: Flowchart depicting the recommended strategy for prevention of scarring.

Table 1: International Advisory Panel of Scar Management classification of different types of scars^{2,7}

Scar type	Appearance	Characteristics
Mature	<ul style="list-style-type: none"> •Light-coloured •Flat 	
Immature	<ul style="list-style-type: none"> •Red 	<ul style="list-style-type: none"> •Slightly pruritic and painful •Can develop into a linear hypertrophic scar
Linear hypertrophic	<ul style="list-style-type: none"> •Rope-like appearance •Red •Raised •Confined to the border of the original injury 	<ul style="list-style-type: none"> •Develops weeks after initial insult •May slowly grow
Widespread hypertrophic	<ul style="list-style-type: none"> •Widespread •Red •Raised •Confined to the border of the original injury 	<ul style="list-style-type: none"> •Burns are the main cause
Minor keloid	<ul style="list-style-type: none"> •Raised •Extends <0.5 cm beyond the border of the original injury 	<ul style="list-style-type: none"> •Develops months to years after the event •Does not regress •High recurrence rate
Major keloid	<ul style="list-style-type: none"> •Large •Raised •Extends >0.5 cm beyond the border of the original injury 	<ul style="list-style-type: none"> •Slightly pruritic and painful •Continues to grow •Does not regress •Very high recurrence rate

the scars have formed [Figure 2]. The first step in scar prevention is meticulous attention to presurgical details, operative procedures and postoperative wound care. Certain surgical techniques—such as making incisions along tension-free lines, approximating skin edges with minimal tension and maintaining haemostasis—are examples of factors to be considered when aiming to lower the risk of wound scarring.² Furthermore, identifying patients at high risk of developing scars is essential. These include patients with a previous history of scarring and those undergoing surgeries in high-risk scarring regions of the body, such as the neck and thorax.²⁻⁴

Several measures have been shown to prevent scar formation.¹ Silicone-based products (i.e. gels, sheets and tapes) are the preferred preventative measure.⁸⁻¹⁰ Such products should be applied after epithelisation is established and used for at least a month to maximise results. Silicone sheets are commonly available and should be applied for at least 12 hours per day. Silicone gels, creams and ointments are acceptable alternatives

for face and neck scars as well as for patients in hot or humid climates.⁹⁻¹¹ Intralesional corticosteroid injections are considered second-line approaches in scar prevention.^{12,13} However, silicone and intralesional steroid injections should be used synergistically in high-risk patients. Exposure to sunlight during wound healing has been associated with scar pigmentation; therefore, it is recommended that patients minimise sun exposure during wound healing.⁶⁻⁸

Scar Management

The management of scarring is both complex and challenging due to several factors. The exact pathophysiology of scar formation has yet to be completely elucidated, although several factors are believed to play a role, including the degree of tension across the edges of the wound and the speed of cell growth.^{9,10} Variable systems exist to quantify changes in scar appearance and there is also a lack of theoretical models available to evaluate current therapies. This has led to a limited amount of useful data derived from prospective randomised studies. Nevertheless, there are several measures which can be utilised for the prevention and treatment of scars.

GRADING AND CLASSIFICATION

In order to tackle the issue of scar management, a grading system must be used as a common framework as this is critical in determining treatment for affected patients. Cutaneous scars can be graded based on pigmentation, vascularity, pliability, thickness, height and depression, as well as patient factors such as comfort and acceptability.⁴ Several scales have been reported in the literature such as the Vancouver Scar Scale and the Patient and Observer Scar Assessment Scale.^{14,15} These tools have good consistency and acceptability but are heavily subjective and have limited sensitivity with regards to detecting changes in the appearance of a scar.^{4,6} There is currently no gold-standard system to classify or grade scars. Nevertheless, regardless of the scale initially chosen by the clinician, the same scale should be used throughout the course of treatment for that particular patient. The IAPSM suggests that any assessment of a scar should consider the size and thickness of the scar tissue, the severity of the symptoms and any concerns the patient may have.² The IAPSM classification of scars can be found in Table 1.^{2,7}

RECOMMENDATIONS

Measures used to treat scars are largely determined by the type of scar and symptomatology. Below is a

detailed description of current recommendations on scar management based on scar type. It is essential to address symptoms using adequate analgaesics, systemic antihistamines, moisturisers, topical corticosteroids, antidepressants, massage or hydrotherapy.

Immature Scars

Immature scars are scars which are still in the process of maturing and remodelling.^{2,7} These types of scars can potentially develop into linear hypertrophic scars and are considered as such if symptoms persist beyond one month. Therefore, a preventative strategy is recommended. Monthly pulsed dye laser therapy sessions for 2–3 months have been shown to provide some benefit for immature scars.^{16,17} If the scar shows minimal improvement to pulsed dye laser therapy, then fractional laser therapy may be attempted.¹

Linear Hypertrophic Scars

Based on randomised controlled trials, silicone sheets and gels are the recommended first-line treatment strategy for linear hypertrophic scars.^{8,18,19} Success rates are improved if the sheets or gels are applied for at least 12 hours every day for a minimum of two months.^{9,19} If the patient has severe scarring, then augmentation of therapy using intralesional corticosteroid injections or 5-fluorouracil (5-FU) is indicated.^{12,13,20,21} It is important to note that hyperpigmentation and skin irritation at the injection site are well-known side-effects of 5-FU therapy.²⁰

Second-line strategies for linear hypertrophic scars should be instituted if first-line measures fail. Pulsed dye or fractional laser therapies have been shown to help scar regression in persistent linear hypertrophic scars if used in combination with silicone products and/or intralesional injections.^{16,17} Studies have shown that surgical intervention is required if 12 months of augmented treatment fails to treat a scar.² In such cases, tension of the wound edges is almost always evident.² Surgeons should aim to reduce this tension during the procedure. Immediate first-line measures should be instituted post-surgery.

Several surgical techniques have been reported to reduce scar tension in linear hypertrophic scars, including Z- and W-plasty. Both of these well-known techniques have similar recurrence rates.²² New research shows that small-wave or S-plasty is equivalent in effectiveness to the Z-plasty approach.^{6,7} Skin grafts and local flaps are reserved as a last resort if all other strategies fail to treat linear hypertrophic scars.^{1–4} Adjunctive biological therapy such as dermal scaffolds, matrices and epithelial cell suspensions have been reported to enhance wound healing, but evidence in favour of the routine use of these therapies

is currently lacking.²³ Post-surgical use of silicone products and intralesional combined corticosteroid and 5-FU injections are essential in reducing the rate of scar recurrence.

Widespread Hypertrophic Scars

Burns are the main cause of widespread hypertrophic scarring; as such, patients with widespread hypertrophic scars should ideally be treated in a specialised burn unit. Clinical evidence supports the early use of silicone sheets, gels and pressure therapy as first-line strategies for treating widespread hypertrophic scars.^{10–12} If these fail to improve regression of the scar, then fractional ablative laser therapy should be added as a second-line adjunct.^{12,17} Such scars are usually complex and require a combination of therapies, including silicone products, pressure therapy and surgical procedures such as skin grafts, contracture release and flaps.²⁴ Furthermore, burn scars can cause significant pruritus and pain; therefore, neoadjuvant therapies such as analgaesics and systemic antihistamines are essential before embarking on significant surgical reconstructive procedures.^{1,7}

Minor Keloids

For minor keloids, silicone sheets or gels in combination with monthly intralesional corticosteroid injections is considered the first line of therapy.^{1,7} Several studies have also shown potential benefits from contact or intralesional cryotherapy in arresting the expansion of minor keloid scars.^{25,26} Cryotherapy generally provokes intense pain when applied; as a result, it is critical to provide adequate oral analgesia and pre-therapy local anaesthesia. If the above treatment does not result in scar improvement after 8–12 weeks, then intralesional 5-FU, laser therapy or surgical resection is warranted.¹ It is important to counsel patients with keloids and inform them that the post-surgery recurrence rate is very high in order to ensure that their expectations are realistic.¹ Partial surgical excision is the therapy of choice if a full excision would damage underlying important structures. Local and free flaps are surgical options in some refractory keloid cases.^{3–6}

In order to reduce the recurrence rate of keloids after surgery, adjunct therapies such as silicone sheets and intralesional corticosteroid injections should be applied promptly. Post-surgery radiotherapy at the keloid site has shown benefits.⁷ Available evidence supports the use of 5-FU following a keloid resection.^{2–5} The use of other chemotherapeutic agents, such as bleomycin, mitomycin C and 5% imiquimod cream, have been shown to slow cell growth, thereby reducing the recurrence rate of keloids post-surgical

resection.^{27–30} However, skin irritation and erythema are common side-effects from such therapies.^{25–28}

Major Keloids

Major keloids are a surgical challenge, particularly as the post-treatment recurrence rate is very high.¹ Current evidence recommends the use of monthly corticosteroid injections and cryotherapy as a first-line therapy.^{2–4} Unfortunately, most major keloids are refractory to this therapy and intralesional 5-FU and surgical intervention is usually required. It is important to transfer patients with major keloids to a specialised plastic surgery unit to ensure improved functional outcomes. Post-surgical prophylactic therapy is even more important in keloids than in other scars.^{2–4}

Emerging Therapies

Understanding the physiology of wound healing is critical in emerging future therapies for abnormal scar formation. Several experimental therapies reported in the literature may soon become standard practice. Gassner *et al.* found that injections of botulinum toxin A (BTA) enhanced wound healing and reduced the rate of scar formation in comparison to a placebo.³¹ Although the biological basis of this scar treatment is plausible—BTA paralyses the local muscles around the edges of a wound, thereby reducing tension—conclusive evidence is still lacking. Most of the published literature are case reports or retrospective studies.^{32–34} As such, there is a lack of randomised controlled trials to assess BTA therapy in scar prevention and treatment.

Other therapies used to prevent or treat scars include calcineurin inhibitors, retinoic acid, tamoxifen, verapamil and interferon alfa-2b.^{3,30} However, such therapies have not yet been supported by randomised controlled trials and there is currently no evidence to support their routine use in clinical practice.

Conclusion

Scars continue to represent a significant medical burden. Wound healing processes and the pathophysiology of scar formation are evolving areas of research and treatment modalities will continue to change accordingly. Current prevention methods strongly supported by the literature include meticulous surgical techniques and the utilisation of silicone products. Scar classification and grading systems are essential in determining the appropriate choice of therapy. Silicone products are the first-line strategy in most cases. Adjunct therapies such as intralesional corticosteroids, chemotherapy, cryo-

therapy, radiotherapy and pressure therapy are useful synergistic modalities if first-line therapy fails. Surgical interventions are usually required for extensive major keloids.

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