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The Modified POSAS: A Novel Approach to Defining Pathologic and Non-Pathologic Scarring

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Abstract

Background—Scarring is a highly prevalent and multifactorial process, yet no studies to date have attempted to distinguish pathologic from non-pathologic scarring.

Methods—This article defines and proposes methods of classifying pathologic scarring as it pertains to clinical presentation.

Results—We propose a new scar scale that incorporates pain and functional impairment.

Conclusion—The modified POSAS scar assessment scale is the first of its kind to factor in the functional deficits, pain and pruritus of scarring into measurements of associated morbidity. This has great potential in evaluating patient response to treatment and analyzing clinical outcomes.

Introduction

Scarring is a multifactorial process with different clinical presentations that affects more than 40 million people worldwide.¹ Due to a lack of clear definitions, the percentage of pathologic versus non-pathologic scarring remains unknown. Defining and distinguishing pathologic from non-pathologic scarring is important for determining the prevalence of disease, for researching and understanding the different cellular and biochemical mechanisms resulting in scarring, and for improving the prevention and treatment of scarring. This article will (i) define and distinguish pathologic from non-pathologic scarring, (ii) discuss methods of quantifying function, pain, and pruritus of scarring, (iii) describe a new scar scale that incorporates the components of pathologic scarring, and (iv) explain how differentiating pathologic from non-pathologic scarring will facilitate clinical trials.

Pathologic and Non-Pathologic Scar Defined

The terms “scar”, “fibrosis”, “fibrocontractile”, “cicatrix”, and “contracture” are often used interchangeably without consensus of their meaning.¹ The presence in the English language of these multiple redundant terms indicates that scarring is a significant problem and that many different separately identifiable problems related to scarring are frequently grouped

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together as one. There is a need for clarity. While most physicians can recognize a scar on presentation, defining and distinguishing pathologic versus non-pathologic scarring remains a matter of debate.^{1,2} In the most comprehensive article to date, Mustoe et al. standardized scar terminology in a meta-analysis of over 300 published studies on scar prevention and treatment. The authors distinguished mature from immature scars based on pigmentation and sub-classified hypertrophic scars as “linear” versus “widespread” based upon their appearance, growth phase patterns, and etiology.³ According to this practical classification scheme, treatment algorithms were proposed. Gangemi et al. identified pathological scars as those that have “an evolution in time that is completely different from the regular course of wound healing”; included in this definition were widespread scars, atrophic scars, scar contractures, hypertrophic scars, and keloids.⁴ The approaches taken by both authors exemplify current attempts to classify scarring based on observation (e.g. presentation, appearance, or histopathology). To date, scarring has not been considered from a disease perspective.

The term “disease” is defined as “any impairment of normal physiological function affecting all or part of an organism, or a pathology which causes significant pain or suffering that interferes with daily living”.⁵ Considering pathologic scarring as a disease and non-pathologic as normal wound healing, we propose that pathologic scarring be defined as scarring that causes significant pain, pruritus and/or functional impairment of an organ. Significant pain and pruritus are defined as interfering with activities of daily living. Based on these distinctions, not all hypertrophic scars are pathologic. For example, a hypertrophic scar that forms a contracture posing functional limitations is pathologic, but a hypertrophic scar that covers a 4×4-cm area on the mid-back is non-pathologic (Table 1).

The Morbidity of Scarring: Functional Impairment, Significant Pain, and Pruritus

Functional Impairment

Contractures over joints may dramatically influence patient quality of life secondary to functional impairment, restricted activities of daily living, social anxieties and chronic pain. Joint contractures are frequently studied in the context of burn injury. In the upper extremity, they impair the ability to perform fine-motor tasks and to groom and feed oneself, whereas lower extremity contractures affect the ability to ambulate and transfer.⁶ The location of the deformity and degree of contracture both determine the significance of disease. This is exemplified in Dupuytren’s disease, where a 5-degree flexion contracture of the proximal interphalangeal joint is an indication for surgery, but a 25-degree flexion contracture of the metacarpal phalangeal joint is not.^{7, 8} Objective data can be obtained with a goniometer and by evaluating alterations in activities of daily living.⁶ Current studies continue to grapple with characterization and classification of scarring, and hence the incidence and severity of the problem remains poorly defined. In a study by Schneider et al., 1090 cases were analyzed to (i) determine the incidence of contractures in burn patients at discharge from the acute-care hospital, (ii) describe the most frequently contracted joints, and (iii) determine predictors of the presence, number and severity of contractures.⁶ The authors utilized The Model System for Burn Injury Rehabilitation National Database Data Dictionary to detail the specific methodology for range of motion measurement of each joint.⁹ A normal range of motion was described for each joint, and each impaired joint action was assigned a severity rating determined by dividing the normal range of motion value equally into thirds (mild, moderate, and severe). The authors found that the shoulder was the most frequently contracted joint (38%), followed by the elbow (34%) and knee (22%). Most contractures were mild (60%) or moderate (32%) in severity. Statistically significant ($p \leq 0.05$) predictors of contracture development were length of stay, extent of

burn and graft size. Predictors of the severity of contracture included graft size, amputation, and inhalation injury. Finally, they noted that more than one third of patients with a major burn injury developed a contracture at hospital discharge, highlighting the importance of therapeutic positioning and intensive therapy intervention during acute hospitalization. This study best illustrates how prevalent contractures are and why functional impairment needs to be assessed when evaluating scar-reducing therapies.

Significant Pruritus and Pain

Pruritus and pain secondary to pathologic scarring are known to cause significant morbidity in burn patients.¹⁰ Both symptoms are estimated to affect as many as 87% of adult and 100% of pediatric burn patients.¹¹ In recent years, there has been substantial progress in the elucidation of the pathophysiology of pruritus, which has led to the development of several targeted anti-pruritic protocols in acute burn patients.¹² Treatments include topical emollients, doxepin, systemic gabapentin, antihistamines, transcutaneous electrical nerve stimulation, wound cooling, laser and massage therapy.

Pain secondary to pathologic scarring has also been analyzed in the burn population.^{13, 14} Pain secondary to burn injury is defined by the International Association for the Study of Pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage”.¹⁵ Pain scales have been established to aid in the recognition and adequate treatment of pain. The most popular pain instruments include assessments of cognitive and behavioral components as well as physiologic parameters. The Pain Observation Scale for Young Children, originally described to measure post-operative pain in children undergoing ear, nose and throat surgery, and the COMFORT scale, developed to measure pain in the intensive care unit, remain the most frequently reported scales used in burn patients.^{16, 17} These scales were studied in conjunction with the Visual Analogue Scale for correlation with scar appearance and have recently been validated.¹⁶

The Pain and Impairment Relationship Scale (PAIRS) is another validated scale for analysis of pain.¹⁸ The PAIRS pain scale was devised to assess the extent to which patients believe their chronic, non-malignant pain is associated with functional status or impairment.¹⁹ It reliably measures patients’ beliefs about the relationship between pain and impairment and is used to plan and monitor treatment algorithms.²⁰ It has not been applied burn patients, but its potential application in scar assessment is promising. The PAIRS consists of fifteen statements that explicitly or implicitly attribute impairment and disability to pain. Explicit statements include, “I have come to accept that I am a disabled person because of my chronic pain.” An example of an implicit statement is, “Most people expect too much of me, given my chronic pain.” The patient responds to each statement by circling one of seven responses that range from “completely disagree” to “completely agree” (a 7-point Likert scale). Each response is then converted to a numerical value from 1–7, where “completely disagree” is given a score of “1” and “completely agree” is given a score of “7”. A total score is computed by summing the 15 responses. A high score on the PAIRS pain scale indicates that function is restricted by pain.²⁰ Statistical comparisons between pretreatment and post-treatment PAIR scores are then made by calculating paired sample *t* tests.

A Novel Scar Scale: The Modified POSAS Pathologic Scar Scale

There are currently at least five scar scales that were designed to assess subjective parameters in an objective way: Vancouver Scar Scale (VSS), Manchester Scale (MSS), Patient and Observer Scar Assessment Scale (POSAS), Visual Analogue Scale (VAS), and Stony Brook Scar Evaluation Scale (SBSES) (Table 2). These observer-dependent scales commonly consider factors such as scar height or thickness, pliability, surface area, texture,

pigmentation, vascularity, and pliability.^{21, 22} The scales are best used to determine change within an individual rather than between individuals as they measure a range across a continuum of values. Scar scales are frequently used in research settings, but the assessment of functional scarring is noticeably absent in these scales. The scales do not fully assess the complexity of scarring, which includes the heterogeneity of large total body surface area scars, functional range of motion limitations, and the chronic pain and pruritus that interfere with activities of daily living. (Figure 1). The POSAS is the only scale that considers subjective symptoms of pain and pruritus, yet it does not quantify whether the pain or pruritus interferes with quality of life.

Distinguishing Characteristics of the Modified POSAS Pathologic Scar Scale

Because the POSAS scale contains a patient and observer component, considers symptoms of pain and pruritus, and is considered to be consistent and reliable, we have used this scale as a basis for our novel scale, which is termed the “Modified POSAS Pathologic Scar Scale”. The five novel inclusion factors of the Modified POSAS Pathologic Scar Scale are detailed in Table 3. These factors (highlighted in dark grey) include asking the patient if their daily activities are limited by pain or itching (asterisk-marked, darkened rows in Figure 2 under “Patient Component”) or restricted joint motion (double asterisk-marked, darkened rows in Figure 2 under “Functional Assessment”). If the patient answers “yes” to any of these questions, then the assessor is referred to an algorithm for further assessment (Figure 3). Pain or itching is then further quantified using the PAIRS pain scale.¹⁹ The involved joint is assessed for range of motion according to standardized guidelines.²³ These include maximal flexion, extension, abduction, and adduction as measured by an orthosis or goniometer.⁶ The severity of contracture can be further classified into mild (1/3 joint inhibition), moderate (1/3–2/3 joint inhibition), or severe (>2/3-frozen joint inhibition) for simplicity sake.

How Defining Pathologic and Non-Pathologic Scarring Facilitates Clinical Trials

The goals of research as stated by the National Institutes of Health are to improve people’s health and save lives by investigating ways to prevent and treat disease as well as to increase the understanding of the causes of disease. To achieve these goals, it is essential to distinguish pathologic from non-pathologic scarring as outlined by the Modified POSAS Pathologic Scar Scale. The Modified POSAS Pathologic Scar Scale will enable scientists and clinicians running clinical trials to determine outcomes based on a more rigorous analysis of scars that include quality of life improvements. Current scar scales are narrowly focused and their use is limited to analyzing the aesthetics of small linear scars. Certainly, small linear scars do not have the same impact as large burn scars that restrict joint motion or cause significant pain.

Conclusion

Scarring is a highly prevalent, heterogeneous problem that is caused by complex mechanisms. There is a need to improve treatment modalities and better classify scarring. Considering scarring from a pathologic versus non-pathologic perspective, as determined by functional assessment and the presence of significant pain and pruritus that limit daily activities, will facilitate research and enhance the development of treatment modalities. The proposed classification scheme and novel scar scale described herein improve upon the tools used in basic research and outcome studies. The modified POSAS pertains to the study of scars and evaluation of potential therapeutics in plastic surgery practice. The burden of scarring is significant. It is pathologic scarring that forever alters the lives of patients.

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Figure 1.

Three different scars are presented to illustrate the wide variety of scarring: (A) scarred neck with contractures, (B) large total body surface area scar that is heterogeneous with contracture, and (C) a linear scar. Existing scar scales are useful to evaluate (C) linear scarring but not (A) functionally debilitating scarring or (B) large total body surface area scars.

Observer Component											
Normal Skin	1	2	3	4	5	6	7	8	9	10	Worst Scar Imaginable
Vascularization											
Pigmentation											
Thickness											
Relief											
Pliability											
Patient Component											
No complaints	1	2	3	4	5	6	7	8	9	10	Worst Imaginable Symptoms
Is the scar painful?											
How frequent is the pain?											
Does the pain limit you from daily activities?											
Does the scar itch?											
How frequent is the itching?											
Does the itching limit you from daily activities?											
Normal Skin	1	2	3	4	5	6	7	8	9	10	Yes, very different
Is the color of the scar different?											
Is the scar more raised?											
Is the thickness of the scar different?											
Is the scar irregular?											
Functional Assessment											
Does the scar limit you from daily activities?											

Figure 2.

The Patient and Observer Scar Assessment Scale (POSAS) was used as a basis for creating The Modified POSAS Pathologic Scar Scale. The modified scale now assesses the impact of pain and pruritus on activities of daily living. It also determines whether scarring affects function. If the pain or pruritus are reported to limit daily activities (darkened rows with “*” under “Patient Component”), then the impairment can be further assessed using the Pain and Impairment Relationship Scale. If scarring affects function (darkened rows with “**” titled “Function Assessment”), then the severity of the dysfunction can be determined by quantifying joint range of motion.

Figure 3.
An assessment algorithm for scars that interfere with activities of daily living (ADL).

The defining characteristics of pathologic and non-pathologic scarring. The key discriminating factor in determining whether a scar is pathologic or non-pathologic is whether the scar interferes with activities of daily living

Table 1

Pathologic	Scar Deficit	Non-pathologic
Interferes with activities of daily living	Functional	No impact on activities of daily living
Interferes with activities of daily living	Pain/Pruritus	Insignificant Symptoms

The most commonly used scar assessment scales including the Vancouver Scar Scale, Manchester Scale, Patient and Observer Scar Assessment Scale, Visual Analogue Scale, and Stony Brook Scar Evaluation Scale are presented for comparison including attributes, advantages and deficiencies. None of the scar scales measure the functional disability caused by scarring and the effects of pain and pruritus in terms of activities of daily living

Table 2

Scale	Scoring System	Attributes Analyzed
Vancouver Scar Scale	0 to 13	vascularity, height/thickness, pliability, and pigmentation
Visual Analogue Scale with Scar Ranking	0 to 100 "excellent" to "poor"	vascularity, pigmentation, acceptability, observer comfort <i>plus</i> contour and summing the individual scores
Patient and Observer Scar Assessment Scale	5 to 50	VSS <i>plus</i> surface area; patient assessments of pain, itching, color, stiffness, thickness, relief
Manchester Scale	5 (best) to 18 (worse)	VAS <i>plus</i> scar color, skin texture, relationship to surrounding skin, texture, margins, size, multiplicity
The Stony Brook Scar Evaluation Scale	0 (worst) to 5 (best)	VAS <i>plus</i> width, height, color, presence of suture/staple marks