OBJECTIVE CRITERIA IN EVALUATING THE CONSEQUENCES OF THE POSTTRAUMATIC SCARS

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ABSTRACT

Most of the population has scars which are related to a traumatic event. In current forensic practice, two-dimensional measurement of the scar surface is used to analyze a scar, but for an objective evaluation of the scars, it would be necessary to measure its volume to capture all the characteristics. Moral suffering as a negative consequence of the presence of the scar should also be measured by using psychometric scales to attest the degree of internalization or production of aesthetic damage given that any person suffers from the awareness of unsightly wounds or scars. This article reviews the literature on available tools and existing assessment methods used to objectively and subjectively characterize scars of various etiologists. car assessment devices must be non-invasive, accurate, provide reproducible data, be easy to use to facilitate data collection, and have clinical support. Existing devices can evaluate such parameters as foldability, firmness, color, perfusion, thickness, and, three-dimensional topographies. In this study, we described the main scales that consider the analysis of scars, being represented by aesthetic, observational, and psychometric scales. The psychometric scar scales will objectify the negative consequences of scars, these consequences are felt mainly in the family and professional, without losing sight of the fact that any person suffers from awareness unsightly wounds or scars. The consequences of aesthetic damage have negative effects on the family and profession, but especially on the decrease in self-esteem and self-confidence of individuals with unsightly scars.

Introduction

Scars on the skin are a normal and inevitable process of healing a lesion caused by a trauma to the human species [1]. The morphology of the scars acquires a varied aspect, starting from a simple fine line, to the arrangement on a large surface of the skin, from atrophic forms to hypertrophic forms, to scars that produce contractions and those that produce functional impotence when they pass over a joint. Most of the population has scars that are related to a traumatic event that they accurately recall, and this is especially true for scars on the face, but also on the rest of the body if they are of significant size [2-4].

The standard procedure of the forensic doctor is to write in detail the morphological characteristics of the scar and eventually to take pictures if there is any doubt about the identity of the person. Scars that affect areas of importance in expressing non-verbal language or those that alter the natural symmetry of the face lead to aesthetic damage [5]. To be successful, an aesthetic intervention should represent the optimal balance between science, the art of plastic surgery, and the patient's expectations, as well as good communication between the surgeon and the patient [6].

Aesthetic damage is a current problem today. It can be defined as a sequelae change in the face that alters aspect, symmetry, or face mobility, not constituting a loss of organ or infirmity [7]. To determine its permanent character, the final forensic assessment must be made at a longer interval from the occurrence of the trauma and after the exhaustion of all therapeutic methods, plastic surgery, and reparatory or physiotherapy [8].

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In current forensic practice, a bi-dimensional measurement of the scar surface is used to analyze a scar, but for an objective evaluation of the scars, it would be necessary to measure its volume to capture all the characteristics of the scars [9, 10]. Moral suffering as a negative consequence of the presence of the scar should also be measured by the use of psychometric scales attesting to the degree of internalization or production of aesthetic damage [11].

Post-traumatic scars have long-term physical and psychosocial effects. Post-combustion scars after deep dermal lesions are cosmetically disfiguring and force the scarred person to cope with a change in body appearance. Therefore, the traumatic nature of the burn accident and painful treatment can induce psychopathological responses. Depression and post-traumatic stress disorder were prevalent in 13-45% of cases according to scientific studies in patients with scars. Social problems include difficulties in sexual life and social interactions. Quality of life appears to be lower in patients with scarring compared to the general population, individuals from the first category often requiring psychiatric therapy [12, 13].

Materials and Methods

This paper aims to identify and analyze the most important psychosocial determinants of post-traumatic and surgical scars. Relevant studies were used for an exploratory investigation of this area of research. The relationships between clinical and psychosocial characteristics of patients with scarring were assessed based on reported studies. To this end, the literature has been identified using Medline, PubMed, PsychLIT, PsycINFO, Scopus, ProQuest, Science Direct, SpringerLink, and WoS including keywords such as scar, helplessness, hopelessness, depression, social support, prognosis scars, posttraumatic scars, consequences scar, criteria scars, scar assessment, consequences scars, etc. Studies reporting data on scarring in children were excluded. The screening criteria for inclusion and exclusion were determined. First, only the journals with studies that had as primary sources with empirical data were selected. Second, to avoid misinterpretation and misunderstanding, search efforts included only articles published in English. Thirdly, in terms of chronology, a period of 15 years was selected (between 2006 and 2021). The selection was implemented to ensure sufficient time to observe the evolution of international research. We also consider that we provide a sufficient time frame to be able to identify the appropriate items. Eligibility was the step in which the additional and more in-depth examination is performed by the authors. This step is done by reviewing the titles, abstracts, and main content of each article to ensure that they meet the inclusion criteria.

Results and Discussion

Scar assessment devices must be non-invasive, accurate, provide reproducible data, be easy to use to facilitate data collection, and have clinical support. Existing devices can evaluate such parameters as foldability, firmness, color, infusion, thickness, and three-dimensional topography [9].

Foldability can be achieved with the help of a pneumotonometer and cutometer; pneumotonometer uses air pressure to objectively measure skin foldability, but is dependent on the location of the skin on the body and has shown a total lower foldability of post-combustion scars regardless of location, compared to the control group [14]. Cutometer is a non-invasive suction device that is applied to the objective and quantitative assessment of skin elasticity [15]. Draaijers *et al.* [16] applied the cutometer to measure the foldability of scars, proving that it is a reliable tool to measure the elasticity of scar tissue.

Firmness can be achieved using the durometer which was originally used in scleroderma [17], but it was subsequently applied for the analysis of the hardness of post-combustion scars, although the recorded results demonstrate a large observer-dependent variability [18].

The color of the scars is another parameter that can give reports about the changes of the scar. A systematic review published by Langeveld, *et al.* in 2021 aims to determine the most reliable and validated medical devices available for color assessment, analyzing 11 studies, describes 16 different measuring devices and 3172 subjects [19]; the most reliable medical device for assessing skin color is Minolta Chromameter CR-300 due to good interobserver and inter-instrument reliability in a caucasian population [20].

Pathological scars may have the characteristic of an increased thickness which is often subjectively documented by palpation [21]. The Ultrasound Tissue Palpation System (TUPS) is an easy-to-use device for assessing scar thickness on various parts of the body [22]. In the study made by Lau *et al.* [23], scars were evaluated using TUPS, as well as the Vancouver Scar Scale (VSS) for assessment of scar thickness, flexibility, pigmentation, and vascularity. TUPS was shown to have high reliability between evaluators, test-retest, and had a moderate correlation with VSS on which clinicians used to assess the scar [24]. Evaluation of scars using laser Doppler imaging (LDI) is another reliable method to determine the thickness of these scars and can predict the risk of hypertrophic scars [25, 26].

Vascularity: Measuring vascularity helps monitor and adapt therapeutic interventions to prevent excessive scarring. Vascularization can be measured non-invasively using both subjective scales such as the Patient and Observer Scar Assessment Scale (POSAS), the Vancouver Scar Scale (VSS), and the Vancouver Modified Scar Scale (mVSS), and objective measuring devices of color, blood flow, and angiogenesis as shown by Deng in a review article published in 2019 on vascular analysis in 26 articles. It turns out that subjective scales are easy to use and have acceptable reliability to provide a preliminary impression of scar vascularity [27].

Digital Image Correlation (DIC) is a full-field, non-contact 3D optical technique that has been able to differentiate the mechanical qualities of the skin, having the advantage of precise measurements, large measuring areas, and easy viewing.

Advanced imaging methods offer great perspectives in the objective analysis of pathological scars, but their cost is higher than classical two-dimensional methods [28, 29].

Scar evaluation scales
The aesthetic method derived from Greff's and Hodin's methods
In Romania, the forensic practice uses an aesthetic method derived from Greff and Hodin's method to assess aesthetic damage. This method divides the face into sectors and correction coefficients are added. The human body is divided into the facial area and the rest of the body. The facial area comprises the face or image of the face and the lateral sectors. Conventional lines divide the anterior area of the face into 72 sectors, and the anterior and lateral facial region is divided into 25 sectors on each side of the face, thus totaling 122 areas to which the correction coefficients are added. The correction coefficients used by the method derived from Greff's and Hodin's methods are represented by the basic coefficient, fracture correction, unevenness, plastic, color, and texture coefficient. The calculation formula is thus obtained for each affected sector with a maximum value of 9,975 which is rounded to 10: $Cs = C \times F \times R \times c \times P \times T$, but the result of this formula has no interpretation in the case of aesthetic damage [30-32].

Vancouver scar scale
The Vancouver Scar Scale (VSS) or Burn Scar Index was introduced in 1990, being the first scar assessment scale widely applied and validated in clinical practice. This scale was designed and applied for the assessment of post-combustion scars, but has remained among the most commonly used scales to date. The parameters on which this scale is based are represented by the thickness and height of the scar, vascularity, pliability, and pigmentation. The score obtained can vary between 0 and 13 points [33].
VSS set a precedent in the systematic evaluation of scars, it allowed a semi-quantitative approach to subjective characteristics, is widely used in clinical practice and research to document the change in the appearance of scars [34, 35]
This scale also has disadvantages demonstrated by multiple studies: inaccurate evidence of reproducibility, especially in the case of large or irregular scars; does not take into account certain symptoms such as pain and itching, functional and psychological sequelae of scars [36].

Seattle scar scale
Seattle Scar Scale (SSS) was developed in 1997 by Yeong *et al*. as a scale for assessing scars using photography [37]. This scale assesses several parameters such as surface area, height, thickness, and color differences between the scar and the adjacent normal skin, using a numerical scale, and the evaluation is based on 24 standard color photographs.
SSS has an improved concordance, its design allows negative values for hypopigmentation or atrophy which helps to distinguish different types of scars, which has led to a better objectification of the severity of the scar [38]. The disadvantage of this scale remains the non-inclusion of subjective symptoms which has limited the use of the scale worldwide [9].

Hamilton scale
Photographs are frequently used to document the change in the management of hypertrophic scars. The Hamilton scale was developed in 1998 as an instrument for the evaluation of scars through photographs. Observers appreciated parameters such as scar thickness, surface irregularity, vascularity, and color using only photographs. The most important advantage of this scar evaluation scale was the fact that it showed increased ability even if it was used by inexperienced people, with interoperable reliability between 0.66 - 0.90, and the test-retest ability was from 0.73-0.89.15 [39]. The disadvantage of this scale is that it is not based on real scars, this aspect could distort the evaluation. Another disadvantage is that the Hamilton scale does not take into account the subjective symptoms, implicitly or the mental damage [35].

Patient and observer scar assessment scale
The Patient and Observer Scar Assessment Scale (POSAS) was initiated in 2004, being the first scale that takes into account both the observer's and the patient's assessment. This scale evaluates the characteristics of scars such as vascularity, thickness, pigmentation, pliability, and relief. Patients also evaluate the pain and itching associated with scars on a scale of 1-10 [40]. Draaijers *et al*. compared the reliability and validity of POSAS with the most widely used scale, namely the Vancouver Scar Scale, demonstrating less variability but greater reliability [41].
An important step is that the POSAS scale takes into account the subjective characteristics, namely pain, and itching, but ignores the quantification of the psychological and functional impact caused by the scar [42, 43].

Psychometric scar assessment scales

Mekeres' psychosocial internalization scale
Mekeres' Psychosocial Internalization Scale (MPIS) was conceived in 2017 following a study of 204 participants who presented with scars, divided into two relatively homogeneous groups, of which 105 women and 99 men, aged between 18 and 81 years after were assessed for eligibility according to inclusion and exclusion criteria in the study. Study participants responded to 15 listed statements, after assessing themselves on a Likert scale between 1 (disagree) and 5 (strongly agree),

choosing the rate that corresponds to their personal opinion. The rating of the MPIS scale represents the sum in a total score between 15 and 75 points. The main objective of the scale is to quantify and objectify the psychosocial impact of scars and interpret the results so that the forensic pathologist or lawyers can use it to determine whether or not the patient has cosmetic damage [44].

Multidimensional scale of perceived social support

The Multidimensional Scale of Perceived Social Support (MSPSS) describes the development of a self-reported measure of socially assessed social support by Zimet *et al*. in 1988 including 136 female and 139 male university students in the study. Three subscales were identified, each addressing a different source of support, which had strong factorial validity: (a) Family, (b) Friends, and (c) Significant others. In addition, research has shown that MSPSS has good internal reliability and test-retest, as well as moderate construct validity [45].

Social support is an important component that protects the person against physical and mental threats, and it mainly concerns relationships and comfort given by the feeling of appreciation, acceptance, and self-esteem and especially by emotional support in times of crisis. The high level of perceived social support was associated with low levels of depression and anxiety symptoms, as measured by the Hopkins Symptom Checklist. This scale was validated on the Romanian population by Marian in 2006, presenting 12 items that were distributed in subscales following: the social perception of friends, family, and acquaintances. Study participants answer 12 questions with Likert-rated answers between 1 (strongly against) and 7 (strongly agree) [46].

Hopelessness depression symptom questionnaire

The theory of hopelessness supports the existence of hopeless depression, a subtype of depression that is supposed to have a set of symptoms, a characteristic causal profile, and a certain course. In 2012, an analysis was carried out and Marian published a study from an experimental point of view, which shows the Hopelessness Depression Symptom Questionnaire (HDSQ) on the Romanian population and also establishes its psychometric parameters. The results of the factor analysis in the case of the 315 participants support the initial factors of HDSQ, but also reflect a distinct symptom of despair depression [47]. The results of the stress-diathesis, explained by modeling the structural equations, confirm the theoretical hypotheses issued by Abramson, Metalsky, and Alloy (1989) regarding the onset of depression. It confirms the effectiveness of HDSQ as a clinical tool for assessing hopeless depression and its theory of it [48, 49].

Considering that each minor subscale measures a specific symptom, HDSQ is a clinical tool that allows researchers and clinicians to test the symptoms of depression independently and not just an overall score (to determine the disorders' severity). When an individual experiences negative events in the same domain (e.g., social rejection), the logic of stress predisposition components has revealed that the style of attribution in a private domain (like interpersonal events) attracts a specific vulnerability to symptoms of depressive despair [50].

Conclusion

Scars on the skin are a normal and inevitable process of healing a lesion caused by a trauma to the human species. Existing devices for assessment of scar parameters such as flexibility, firmness, color, perfusion, thickness, and three-dimensional topography, but the negative consequences of a scar are missing. Studies that critically compare subjective scar assessment tools with objective measuring instruments through emerging devices are lacking. In addition, most current studies, classification schemes, and methods for assessing scars are being developed and researched on post-combustion scars. Pathological scars seem to have a higher prevalence after burns than after surgery or trauma. However, few studies to date have described and analyzed the dynamics of post-combustion and postoperative pathological scars. The psychometric scar scales will objectify the negative consequences of scars, these consequences are felt mainly in the family and profession, without losing sight of the fact that any person suffers from awareness of unsightly wounds or scars.

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