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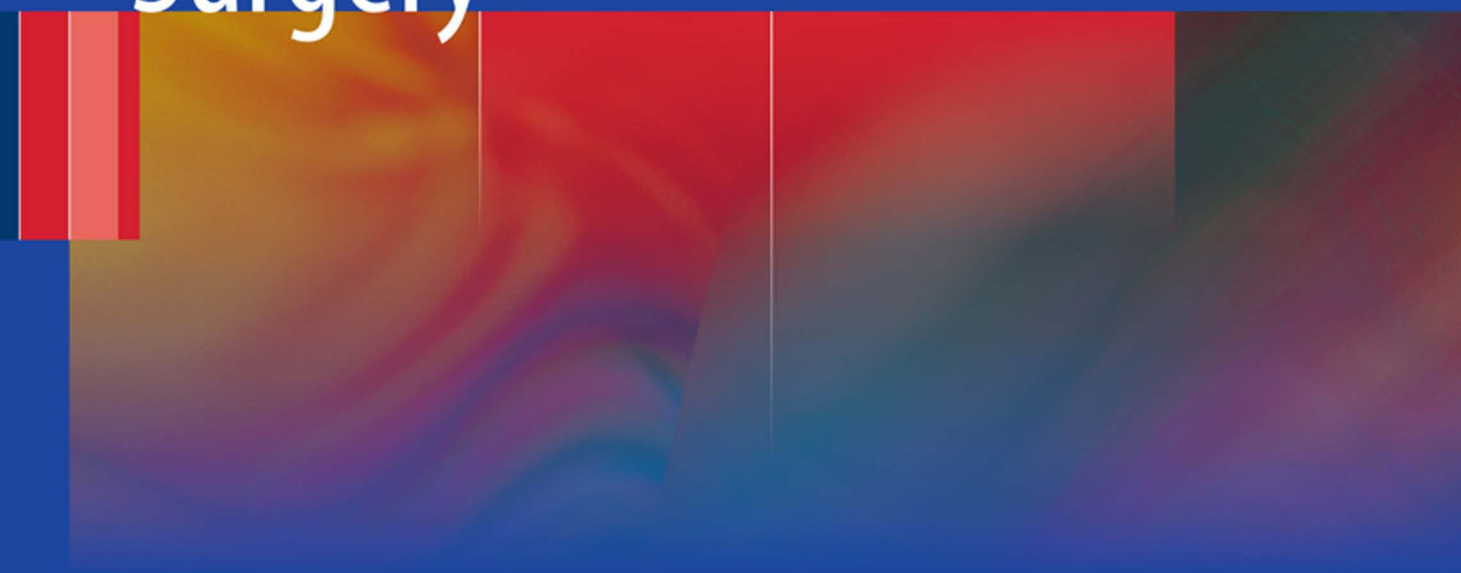
Color Atlas of Burn Reconstructive Surgery



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Prefaces

Reconstructive surgery of burns, especially of extensive burns, is a topic that requires the ideas and inspiration of plastic surgeons. Traditionally, it is considered that almost all burn wounds can be reconstructed using simple skin grafting. However, sophisticated reconstructive surgery based on knowledge of various surgical methods is needed to accomplish both functionally and cosmetically acceptable long-term results. The contents of this book represent ideal *guidelines* for burn reconstructive surgery and were provided by authors from 14 different countries. In other words, this book is the grand sum of the newest surgical technologies and strategies proposed by plastic surgeons.

I have been involved in reconstruction surgery for extensive burns since I became a plastic surgeon. I have developed many reconstructive procedures and have been able to apply these methods clinically. Burn reconstruction has brought many thoughts to develop flap surgical methods to me. Moreover, I have realized that burn reconstruction should be accomplished via an all-out mobilization of knowledge on flap surgery and that this is an area that requires continual development of surgical methods. However, I have met many plastic surgeons who are performing novel and innovative methods. This book is a collection of these worldwide experiences. I hope that this book will provide great benefits for burn patients worldwide.

Tokyo, Japan — Hiko Hyakusoku, MD, PhD

Damage to skin from thermal, electrical or chemical injury has devastating effects on aesthetic and functional outcomes of burn victims. The stigmata of burn patients remains one of the most devastating injuries that man can survive. Fortunately, over the last 30 years, there have been simultaneous advances in scar biology, materials science and knowledge of microanatomy, surgical techniques, transplantation and cell culture. As a result there are now many treatment options available that give greater hope to our patients restoring function and improving their societal interactions.

In this atlas, Dr. Ogawa has brought together the world's experts to review the important topics of super-thin flaps, pre-fabricated flaps, dermal and epidermal replacements as well as vacuum-assisted closure technologies. This atlas will be an important resource for practicing plastic surgeons as well as students and residents in training. Examples in the atlas will also be valuable for patient education of these varied techniques.

Boston, MA, USA

Julian J. Pribaz, MD
Dennis P. Orgill, MD, PhD

Burns represent a pathology remaining among the hardest to heal wounds. Even if important progresses in rescucitation allowed life-threatening body surfaces to regress during the last 50 years, force is to recognize that restoring the original function after extensive and deep burns requires a long period of fight against contractures, hypertrophy and tissue shortening. A multi-disciplinarity approach is mandatory to obtain a return to the social and working life, but skin has changed for the rest of the life of the patient.

The development of microsurgery in the 80s, followed by an intense activity in anatomical studies could evidence the angiosomes and the skin, muscle, tendon and bone vascular cartographies. From this era, all types of flaps were proposed, including pre-fabricated and perforator flaps, a founding melting pot and a source of intense activity for the new plastic and reconstructive surgery. This atlas details how to use them in burn reconstructive surgery.

During the last decade, the surgical possibilities of dermal replacement becomes more and more efficient. The recent development of tissue engineering, leading to added biological similarities with the normal skin, opens a new space for reflexion and trials, based on cell–extracellular matrix interactions via cytokines and growth factors.

The need for repairing the cosmetic outcome of facial burns remains a social challenge and will certainly be a long-term contract for the new generation of burns specialists and plastic surgeons.

Montpellier, France Luc Téot, MD, PhD

Every reconstructive surgeon thinks that evidence-based burn reconstruction is an ideal method; however, it is yet to be established. The reason for this may be that every single wound or scar is unique. Moreover, the color, texture, thickness and hardness of the skin vary according to human race, age, sex and body site. Thus, we are forced to select treatment methods on a case-by-case basis according to the limited experience of each surgeon.

Meanwhile, during the finishing stage of reconstruction, large parts of the surgical procedure should include elements of aesthetic surgery. In this stage, it may not be an exaggeration to state that evidence-based surgery is not beneficial. Treatment methods should be selected and performed based on the aesthetic sense and cultivated sensitivity of each surgeon. Evidence-based surgery and artistic reconstruction represent a big dilemma that is posed to every burn reconstructive surgeon.

I believe this book, which is entitled *Color Atlas of Burn Reconstructive Surgery* provides an answer for this particular dilemma. This answer may be the fusion of evidence-based surgery and artistic reconstruction. After reading this book, the surgeon will recognize what part of the reconstruction should be carried out using evidence-based surgery and what part should be performed artistically. We should not give up on the generation of evidence-based standardized protocols for patient safety or on the education of younger-generation surgeons. In addition, we should not neglect artistic reconstruction at any time.

In this book, international authors who have wide perspectives in burn reconstructive surgery shared their own valuable experiences and concepts about the characteristics and indications of their methods. The contents include wound management, classification and evaluation of wounds/scars, various artistic and geometric methods and future treatment strategies from a “regenerative medicine” standpoint. I hope that this book will enhance the work of burn reconstructive surgeons and confer tremendous benefits to burn patients.

Finally, I thank all authors and coeditors who have taken time from their busy schedules to assemble this book. In addition, I appreciate the tremendous help of Ms. Ellen Blasig at Springer in Germany. Her contribution was essential for the accomplishment of this project. Moreover, I thank the illustrator Mr. Kazuyuki Sugiu from Studio Sugi’s for preparing the figures.

Tokyo, Japan Rei Ogawa, MD, PhD

Contents

CHAPTER 1

Primary Wound Management: Assessment of Acute Burns

LUC TÉOT

Introduction

The burn is depicted as a traumatic lesion provoked by several possible agents (thermal, chemical, mechanical, or electrical) involving different skin layers to a certain degree. Assessment of the clinical situation is based on (1) evaluation of the total body surface of the burns, and (2) estimation of burn depth.

Visual assessment and vascular evaluation of the wound are crucial [1, 2].

Evaluation of the Total Body Surface of the Burns

Rule of 9

Anatomical area	Head	Upper limb	Lower limb	Ant body (chest + abdomen)	Post body (thorax + back)	Genital area
Estimated % of surface	9	9	9	2×9	2×9	1

TBSA Following Age

Anatomical area	Adult TBSA (% for each side of the structure)	Fifteen year TBSA (% for each side of the structure)	Ten year TBSA (% for each side of the structure)
Head	3.5	4.5	5.5
Neck	1	1	1
Trunk	13	13	13
Arm	2	2	2
Forearm	1.5	1.5	1.5
Hand	1.25	1.25	1.25
Genital area	1	1	1
Buttock	2.5	2.5	2.5
Thigh	4.75	4.5	4.25
Leg	3.5	3.25	3
Foot	1.75	1.75	1.75

Estimation of Burn Depth

Burn depth is traditionally defined in three degrees, and clinical observation remains the main source of information for the clinician, even though some complementary examinations can be useful to determine the exact extent of deep burns. In the majority of cases, the surgical indication for excision and grafting depends upon the visual evaluation of the wound. This part of burn assessment remains difficult and cannot be done with precision, even with experience, before the third day post injury. In second degree burns, the first assessment has been estimated to be accurate in less than 70% of cases.

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Clinical Evaluation

First Degree

The first degree corresponds to a shallow wound. The aspect is red, and the area is extremely painful, as the sensory endings remain intact. A typical example of this is sunburn. Only the superficial layer of the epidermis is involved. When the total body surface is important, complications like cerebral edema can be encountered, but the wound remains easy to heal.

Superficial Second Degree

Superficial second degree burns usually present as blisters, appearing some hours after the accident. Once the blister is removed, the wound can be observed. Redness is uniform and pain is extreme, rarely allowing the physician to touch the lesion. Healing time is short, usually within the first 2 weeks, without aesthetic sequellae. The superficial dermis is exposed, without involving the basal membrane, which guarantees a quick healing in the superficial aspect of the skin (Figs. 1.1–1.5).

Fig. 1.1 Early assessment of second degree burns over the dorsum of the hand. Blister has just been removed. Difficult to evaluate if deep. Reevaluate the next day and the day after

Fig. 1.2 Palmar aspect of the same hand. Same difficulty, but the fact that both aspects of the hand are involved is worse than when only one is involved

Fig. 1.3 Sand burns of the palmar aspect of the feet after walking over a long distance on a hot beach. Second degree, superficial

Fig. 1.4 Fresh scald burns (second degree). Blister appearing progressively. Reevaluate after some hours before establishing a prognosis

Fig. 1.5 Fresh burns of the face. Ophtalmologic assessment. Removal of blisters is necessary before a proper assessment of the burns

Deep Second Degree

Deep second degree burns also present blisters, but after removal, the aspect is white or similar to patchwork. Sensibility to touch is not as important as in more superficial lesions, due to a partial destruction of sensory endings. Blanching of the skin under digital pressure cannot be obtained. These burns have a tendency to heal spontaneously, except in critical general conditions or if TBS burnt is extensive. The wound will stay unhealed or deteriorate and transform into a third degree burn. Usually, healing can be observed within 2–3 weeks, but as the deep dermis is exposed, a permanent scar will remain. These wounds can sometimes require an excision and a skin graft (Fig. 1.6).

Third Degree

Third degree burns are deep burns involving the subdermal structures. Extent in depth can be important, reaching aponeurosis or even bones. Lesions are sometimes circular on the limbs, a source of ischemia for the distal segments, necessitating emergency surgical procedures of discharge incisions to reestablish a normal distal blood flow. Lesions present with a white color and the tissues are hard. A black eschar will be observed after carbonization (Figs. 1.7 and 1.8).

Establishing the risk of vital issue is an important step, most of the time to be realized in emergency. Factors like surface, location of deep burns around the orifices and

Fig. 1.6 Deep grill burns of the plantar aspect of the foot on a diabetic patient. Excision and grafting

Fig. 1.7 Electric burns of the scalp: third degree with possible cortical bone involvement. Deep excision and preoperative assessment of the bone. If necrosed, removal of the outer cortex. The use of NPT may then be necessary before skin grafting

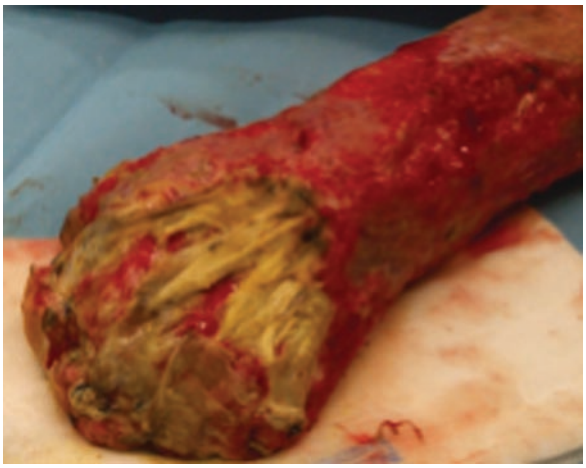

Fig. 1.8 Deep necrotic burns of the hand after digital amputation. Exposed tendons can be covered with negative pressure therapy, with serial excisions of still necrosed structures before skin grafting

Degrees of burns	First	Second superficial	Second deep	Third
Anatomical structure involved	Epidermis	Dermis above basal membrane	Dermis below basal membrane	Whole skin
Color	Red	Red below the blister	Red–white below the blister	White or black
Skin hardness and vascular density	Supple	Humid	Medium hard	Hard thick dry
Bleeding at contact	No bleeding	High	Moderate	No
Pain	Painful	Extremely painful	Painful	No pain
Time for closure	No wound	Less than 2 weeks	Within three to four weeks. Sometimes, needs skin graft	Needs skin replacement (graft, VAC, flap)
Scar formation	No scar	No scar	Notable scar formation and contractures	Notable scar formation and contractures

prevention of infection have to be determined urgently. Above a surface of >10% TBSA in adults and >5% TBSA in children, burns are considered serious. In over 30% of surface in adult and 10% in children, life-threatening difficulties can be encountered. It is important to check the face, nostrils, and hair, to assess the risk of tracheal and pulmonary burns (an endoscopy is often needed for diagnosis when in doubt). The risk of burns infection is higher when initial management is delayed (septicemia).

Conclusion

Establishing the risk of functional issue is focused on reestablishing the limb vascularization and the need for discharge incisions when third degree burns are circumferential. Other functional issues are linked to possible exposure of joints. Immobilization of interphalangeal joints on the hands or ankle must be realized as soon as possible.