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Plastic and Reconstructive Surgery of Burns

An Atlas of New Techniques and Strategies

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Preface

For I neither received it from man, nor was I taught it,
but I received it through a revelation of Jesus Christ.
(*Galatians 1:12*)

In the early 1970s, the first ever 55-bed inpatient Department of Plastic and Reconstructive Surgery opened in the A. V. Vishnevsky Institute of Surgery at the Russian Academy of Science in Moscow, Russia. Being a main referral burn center in Russia, we had an opportunity to operate on thousands of burn patients and we came to the conclusion that more research was needed to develop more effective surgical techniques, especially for severely burned patients. Over the years, we studied the anatomical features of patients with burn complications and developed multiple advanced surgical methods to treat scar deformities of skin and soft tissues, especially postburn contractures of joints and other body areas.

With divine help and revelations from the Creator, the anatomical structure of scar contractures was successfully studied, which led to the development of new methods for the surgical treatment of burns that significantly improved outcomes for the surgical rehabilitation of burned patients.

Some of the most significant results of this research include:

- A direct anatomical cause of contractures was established: for most patients, it is a scar surface deficit of a trapezoid shape. This determines the trapezoid shape of the flap necessary to compensate for the surface deficit.
- Research of the anatomy of the contractures led to a new classification of all contractures: *Edge*, *medial,* and *total* contractures, independent of their location and severity.
- Based on the anatomical research, a more effective trapezoid-flap plasty surgical method was developed, which yields superior results for edge- and medial-type contractures (85% of all the contractures seen in clinical settings).
- New methods of surgical treatments of face and neck deformities were developed due to the identification of axial blood supply to the skin of the neck. Various surgical techniques using split cervico-thoracic flaps were offered for the reconstruction of burned face tissue and contractures of the neck with great results.
- Very important work was done in restoring function of the burned hand (syndactyly, finger contractures, tendinopathies, and arthropathies due to burns). Use of trapezoid-flap plasty for contractures along with mechanical traction devices and tendon transplantation can return function to many disabled patients.
- An effective new method for the reconstruction of the shape, position, and skin of the burned breast was developed.
- We developed a new treatment method for severe adduction contractures of the shoulders based on the use of axillary island skin or scar tissue in the form of a subcutaneous pedicle flap in combination with skin transplantation.
- Sural flap with proximal base was developed and helped resolve the problem with ulcers and skin defects in the Achilles tendon area.

We invite you to expand your knowledge and learn new approaches to burn treatment based on a three-dimensional understanding of tissue deficit and excess. Our extensive experience demonstrated that most contractures can be successfully and completely eliminated without re-contracture as long as the surface/tissue deficit is fully compensated. The first two chapters explain the anatomy of contracture surface deficit and classification based on the location of the scar fold and tissue surplus in relation to joint surfaces. Understanding these principles will enable surgeons to apply recommended surgical techniques to a variety of burn contractures regardless of location and severity.

Many of the surgical procedures described in this atlas provide detailed planning, marking, and step-by-step surgical details, supported by pictures, schemes, and illustrations. We challenge you to step out of the comfort zone of triangular flaps and try your first Y-shaped radial incision to see an additional 30% release of the contracture and the appearance of a trapezoid wound requiring a trapezoid flap. Once you perform your first successful trapezoid-flap plasty, there will be no going back to triangular flaps for most contractures encountered in your practice.

The authors wish success to all surgeons using surgical techniques presented in this atlas. We want to see better outcomes and happy, thankful patients filled with gratitude to God and to the surgeons who offered them help.

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1 Postburn Scar Contracture: Formation, Anatomy and Classification

Introduction

Despite significant achievements in burns treatment, the number of scar contractures is high [1]. Among three burn consequences—scar deformity, contracture, and tissue defect—contractures most often lead to disability. Therefore, efficient treatment of scar contractures is of primary importance in the surgical rehabilitation of burned patients. Treating burn scar contractures remains a challenging problem for reconstructive surgeons, and no definitive conclusions have been reached about the effectiveness of different techniques [2].

"According to the World Health Organization (WHO) burns are a huge global health problem resulting in death and devastation to those who survive large burns as they are faced with significant functional limitations that prevent purposeful and productive living" [3]. For many years, the classic approach to contracture treatment used triangular local-flap techniques and skin transplantation. Existing anatomical contracture names or classifications (linear, wide, wide linear, web straight linear, narrow, long, quadratic, cordlike) do not characterize the contracture anatomy that is the basis for successful surgical treatment. The techniques based on skin grafting and triangular flaps have known disadvantages; therefore, rehabilitation of burned patients with contractures is far from perfect. Our observations show that the absence of progress in scar contracture treatment with local triangular flaps is caused mainly by insufficient study of contracture formation, contracture anatomy, scar surface deficit (contracture cause), and the lack of anatomical classification of scar contractures. Our classification, based on the anatomy of thousands of clinical observations, divides all scar contractures into three types: edge, medial, and total [4, 5].

Functional Zones of Joint Surfaces

In the plane of surgical treatment, a joint's surface is divided into flexion (*F*) and extension (*E*) surfaces; the boundary among them passes along the joint rotation axis level ("+" symbol) (Figs. 1.1, 1.2, 1.3, 1.4, 1.5, and 1.6). The flexion surface (*F*) of large joints (axilla, elbow, knee, ankle, and first interdigital space) has a curvature of nearly 90°, which divides it into two parts: flexion lateral (*FL*) and flexion medial (*FM*). The dividing line passes along the edges of joint fossa, ankle anterior surface, and first web space fossa or between the flexion lateral and medial surfaces. The flexion lateral surface of the large joints (one or both joint sides) spreads from the edge of the joint fossa to the joint rotation axis level. The scars, forming the edge commissural contractures (syndactyly, microstomia), spread from the fold crest on the dorsal and palmar hand to the metacarpophalangeal joints or from the cheek to the normal level of the mouth orifice angle location. Medial flexion surface covers the fossa of large joint, interdigital fossa, ankle anterior, and neck anterior and lateral surfaces.

All flexion rounded surfaces of the small (interphalangeal) joints, neck, trunk, and perineum are considered as one flexion/adduction surface. Scars located on joint flexion surfaces (lateral and medial) cause the corresponding flexion contracture: edge or medial. Scars located on the joint extension surface (beyond joint rotation axis level), do not participate in the flexion contracture formation. The flexion surfaces of the small (interphalangeal) joints, neck, lateral trunk, and perineum are considered as one flexion medial surface. Scars located on joint flexion lateral surfaces cause "edge" contracture. Contracted scars covering flexion medial surfaces form "medial" contracture. Scars that stretch through flexion lateral (FL) and flexion medial (FL) surfaces cause "total" contracture. And scars located on the joint extension(E)

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surface (beyond joint rotation axis level) do not contribute to flexion contracture formation. Scars covering the joint flexion lateral or medial surface and causing contractures are strongly connected to undamaged neighboring surfaces—flexion and extension surfaces.

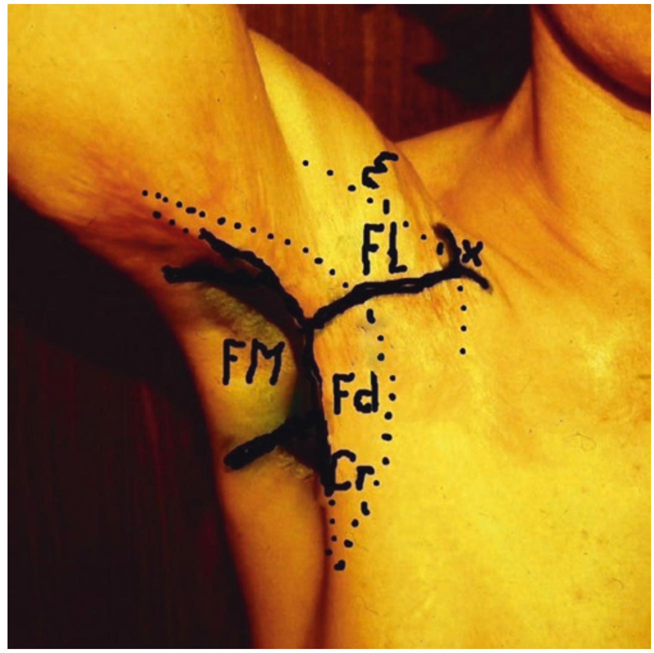

Fig. 1.1 Functional zones of big joint surface and shoulder edge contracture. *E* extension surface above the shoulder joint rotation axis ("+"); *F* joint flexion surface, which is divided by surface curvature into flexion lateral (*FL*) and flexion medial (*FM*); the flexion lateral surface is scars, the medial flexion surface (joint fossa) is healthy skin; scars formed the fold (*Fd*) along the edge of joint fossa; the crest of the fold (*Cr*) is the edge of scars; Y-line—the distance from the fold's crest to the joint rotation axis or joint FL surface

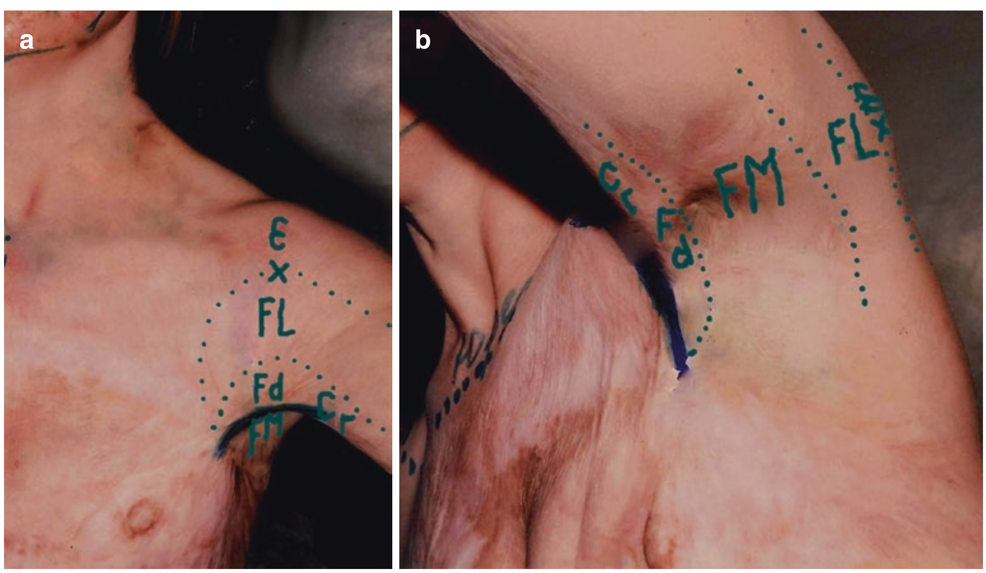

Fig. 1.2 Edge joint flexion contracture formation. (**a**) Scars on the joint anterior lateral flexion surface and neighbor zones spread downward (distally), involving healthy skin of flexion medial surface (*FM*) and form the fold (*Fd*) located along anterior joint fossa edge, among the flexion lateral and flexion medial surface. (**b**) The flexion medial surface of the joint is undamaged (*FM*); therefore, the fold's sheets have a different quality: the lateral surface comprises scars and is the cause of the contracture; the medial sheet and the flexion medial surface are healthy skin (*FM*). The scar has a surface deficit in length from the fold crest to the joint rotation axis ("+") and is the cause of the contracture, and both sheets have a surface surplus; the fold sheets are used for scar surface deficit compensation and contracture elimination

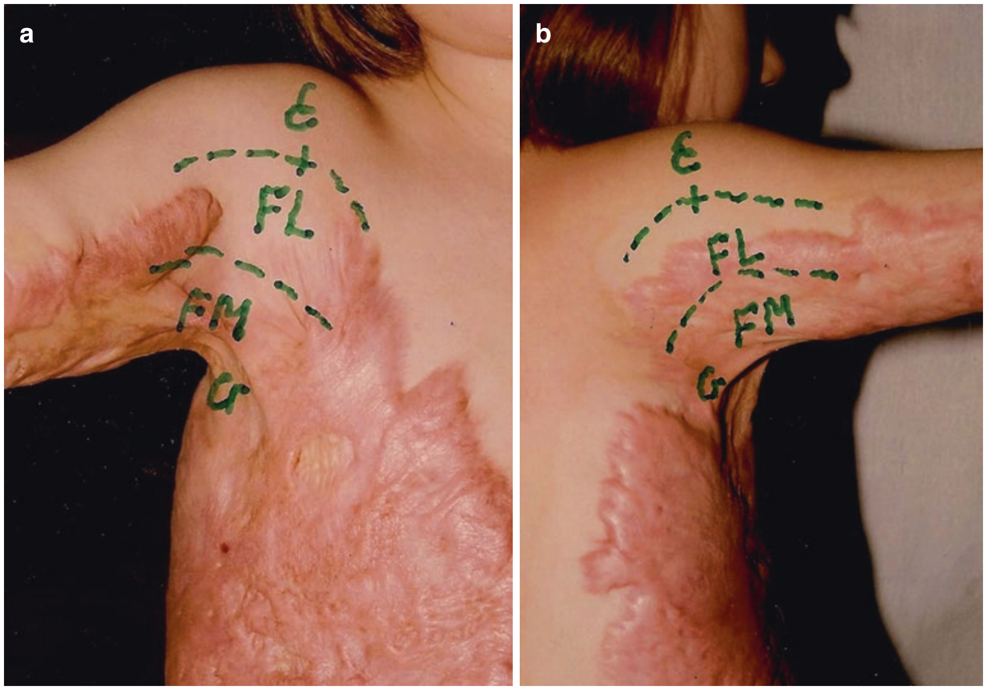

Fig. 1.3 Joint medial flexion/adduction contracture formation. (**a**, **b**) Shoulder joint medial adduction contracture, anterior and posterior view; scars covered flexion medial surface (*FM*), displaced down (distally) and forming a fold that approached the shoulder to chest wall (scar surface deficit in length) and caused the joint contracture; flexion lateral surface (*FL*) and extended surface (*E*) does not participate in contracture formation. The fold crest lies along fossa medial line; therefore, both fold sheets are scars, have a surface deficit in length (contracture cause) and surface surplus in width (from flexion lateral surface [fossa's edges] to the fold crest [*Cr*]), which allows contracture treatment with local flaps

Fig. 1.4 Total shoulder joint flexion/adduction contracture formation. Contracted scars covered the shoulder joint's flexion lateral and flexion medial surfaces and connected the shoulder with the chest wall

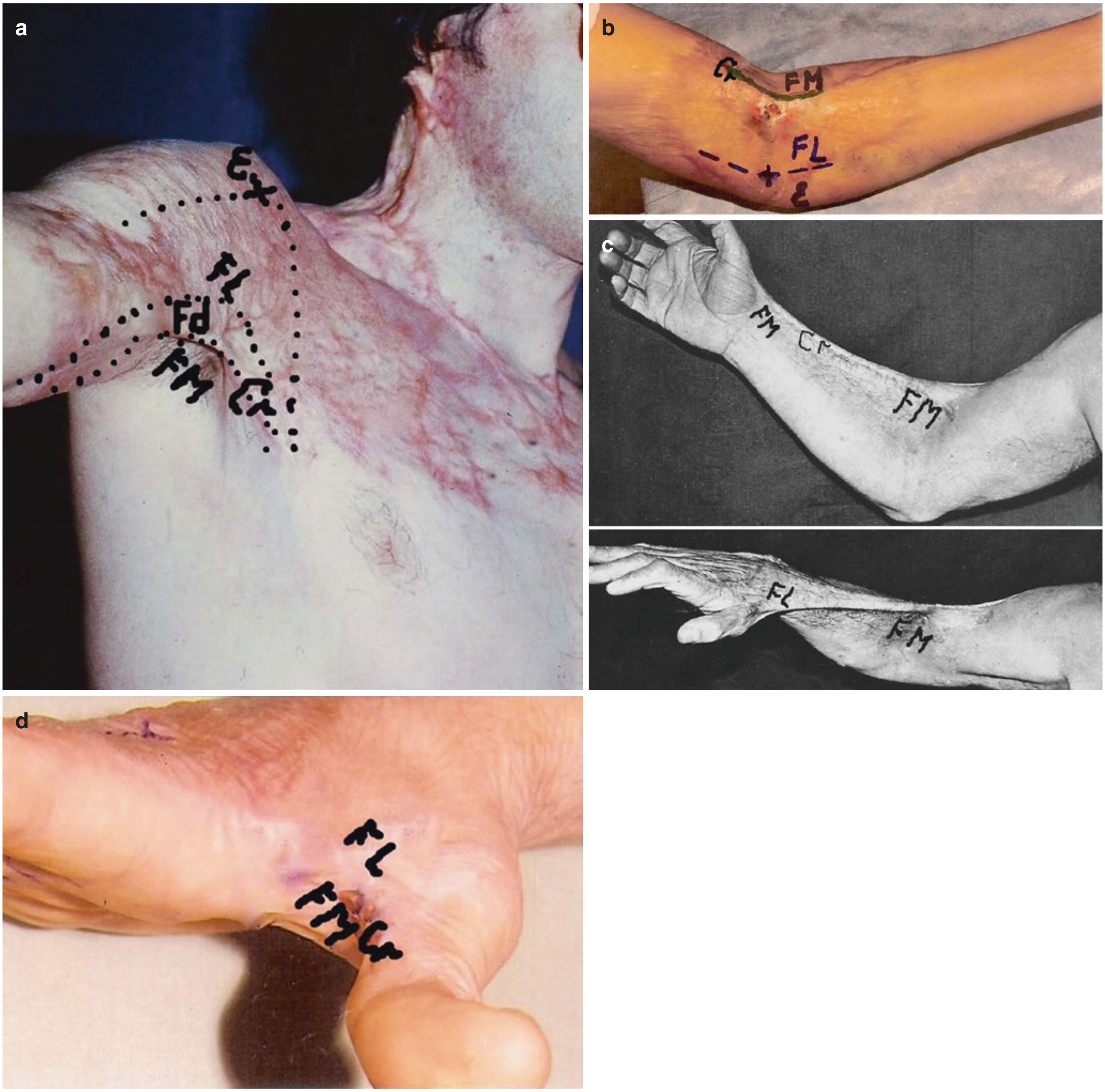

Fig. 1.5 (**a**) Edge shoulder adduction contracture: joint functional zones and anatomy. (**b**) Elbow edge flexion scar contracture. (**c**) Wrist and elbow edge scar flexion scar contractures. (**d**) First web space edge adduction contracture. (**e**) Dorsal syndactyly-interdigital edge commissural scar contractures. (**f**) Inguinal edge contracture. (**g**) Edge knee contracture. (**h**) Edge ankle flexion contracture. (**i**) Lateral neck edge contracture. (**j**) Scar microstomia anatomy

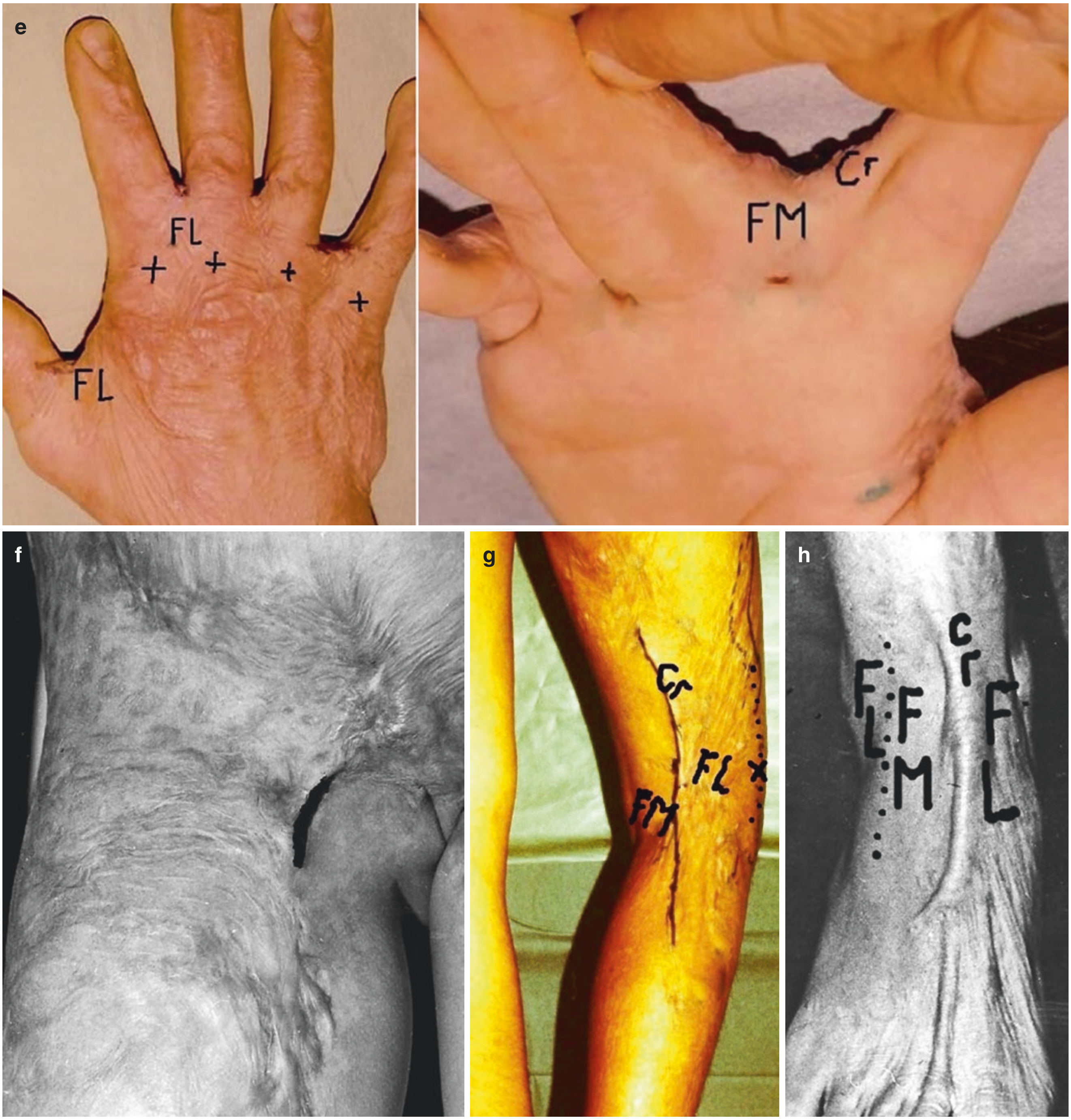

Fig. 1.5 (continued)

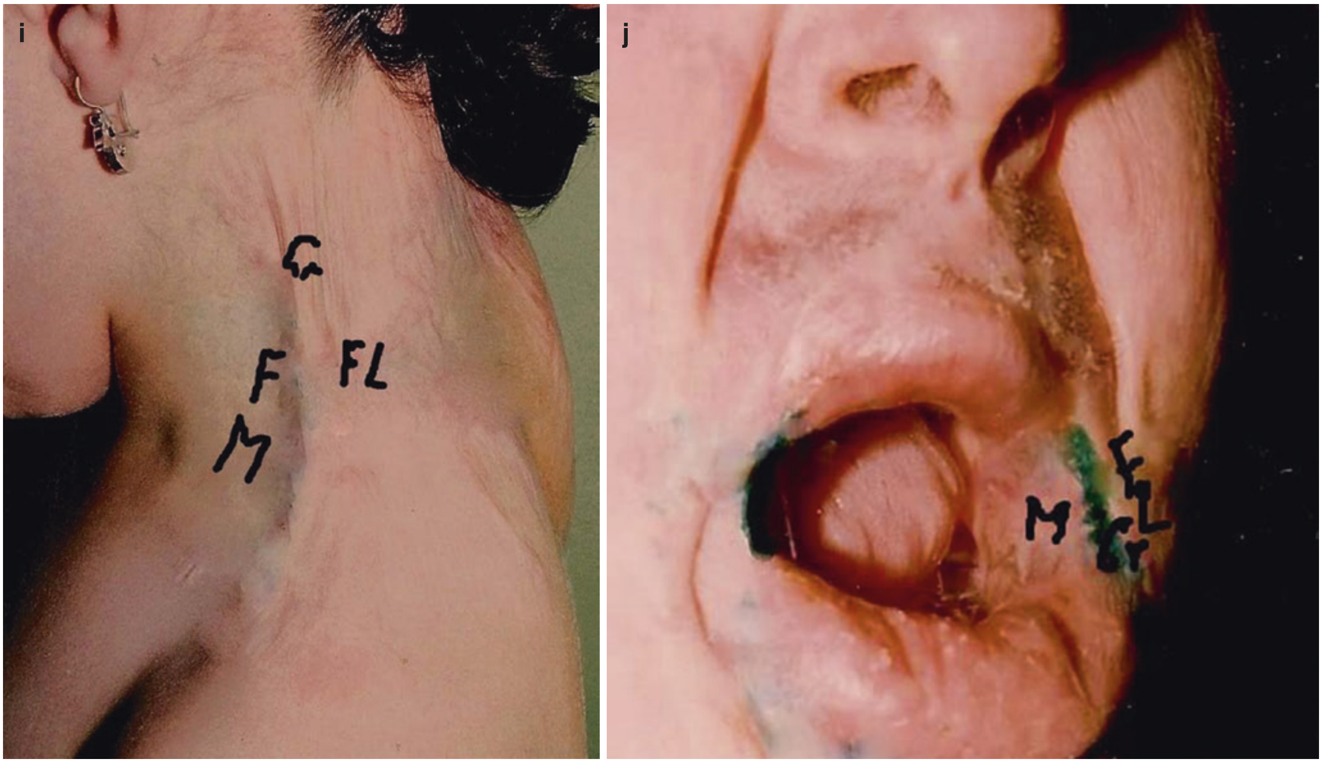

Fig. 1.5 (continued)

Edge Contracture Formation

Burns and scars that cover a joint's flexion lateral surface (*FL*) spread on lateral surfaces of anatomical segments, forming the joint and lateral commissural surface (dorsal and palmar hand and cheek). During wound healing, scars' connective tissue contracts and spreads distally, approaching the neighboring segment (Fig. 1.2). Growing distally, scars involve the healthy skin of the flexion medial surface. As a result, *the crescent fold is formed along the joint fossa's edge* or among the joint's flexion lateral and flexion medial surfaces. After burns to the neck's posterior surface, the fold is formed along the lateral neck; cheek burns are complicated by the fold formation in the oral angle. Scar protrusion increases with time, drawing-in neighboring healthy skin. The resulting crescent fold consists of two sheets of different quality: the lateral sheet is scars, and the medial sheet is healthy skin; scars spread in the direction of the undamaged joint's fossa or flexion medial surface and commissural fossa. Thus, the varied qualities of the fold's sheets are a most important anatomical and clinical feature of edge contracture. The crest of the fold is the scar's edge. Contracted scars located on the flexion lateral (*FL*) surface and the scars of the lateral fold's sheet (continuation scars of FL surface) have a surface deficit in length, which causes contracture, but both sheets are new anatomical structures and have skin and scar surface surplus, allowing contracture elimination with local tissues.

Medial Contracture Formation

Burns of the large joints' fossa or flexion medial surface (*FM*), ankle anterior surface, finger flexion surfaces, commissural fossa, lateral neck and truncal surfaces, and perineum are complicated with growth-contracted scars, which approach the neighboring segment of joints and commissure and cause medial contracture (Fig. 1.3). Attempts to keep the joint extended elevate scars above the flexion medial surface of the joint and neighboring segments, forming a fold. Maximal scar protrusion or crest of the fold passes along the central line of the flexion medial surface of big joints; the lateral neck surface (Fig. 1.3b); the finger flexion surface (Fig. 1.5e); and the lateral truncal surface (Fig. 1.5i). Since scar tension is maximal in the center of the medial flexion zone, both sheets of the fold are scars and are of equal quality. Scar sheets have a surface deficit in length, which causes a contracture, and scar surplus in width, which allows contracture elimination with local flaps. Flexion lateral surface (*FL*) of the large joint can be undamaged or covered with scars that do not participate in the contracture formation. All flexion surfaces of small joints (Fig. 1.5e) and the lateral surface of the trunk (Fig. 1.5i) are totally covered with contracted scars, which are elevated above the finger flexion surface and lateral trunk. As a result, the fold is formed, both sheets of which are scars in which there is a scar surface deficit in length, which causes contracture and a scar surface surplus in width, which allows contracture release with local flaps alone or in combination with skin transplants.