P-ISSN: 2548-5962
E-ISSN: 2548-981X
https://ojs.unud.ac.id/index.php/jbn

REVIEW ARTICLE

Surgical Anatomy of the Hand and Its Clinical Relevance in Burn Reconstruction and Post-Burn Contracture Management: A Narrative Literature Review

Ocly Davira Putri Laisnima[1*], I Gusti Putu Hendra Sanjaya[2], Agus Roy Rusly Hariantana Hamid[2], Shita Diwyani Sudarsa[2], Astrinita Lestari Suyata[2], Gede Wara Samsarga[2]

[1]Resident of Plastic Surgery Reconstruction and Aesthetic Division, IGNG Ngoerah General Hospital, Denpasar, Bali
[2]Division of Plastic Surgery Reconstruction and Aesthetic, IGNG Ngoerah General Hospital, Denpasar, Bali

*Corresponding author: oclydavira@gmail.com

ABSTRACT

Background: The hand is a highly complex anatomical structure essential for functional, sensory, and aesthetic performance. Burn injuries frequently involve the hand and often result in contractures, deformities, and functional impairment requiring reconstructive surgery. A thorough understanding of surgical anatomy is fundamental for optimizing reconstructive outcomes.
Objective: This literature review aims to summarize the surgical anatomy of the hand and its relevance in burn reconstruction and post-burn contracture management.
Methods: A narrative literature review was conducted using anatomical and surgical references. Anatomical structures, mechanisms of contracture formation, and reconstructive surgical strategies were synthesized.
Results: The hand consists of integrated integumentary, musculoskeletal, neural, and vascular systems that enable fine motor control. Burn injuries commonly result in skin loss, scar contracture, tendon adhesion, joint stiffness, and deformities such as boutonniere deformity and syndactyly. Surgical management includes contracture release, Z-plasty, skin grafting, and flap reconstruction.
Conclusion: Comprehensive knowledge of hand surgical anatomy is crucial for effective burn reconstruction. Detailed anatomical understanding allows surgeons to select appropriate surgical approaches and improve functional and aesthetic outcomes.

Keywords: Hand anatomy, burn reconstruction, hand contracture, surgical anatomy, plastic surgery.

DOI: https://doi.org/10.24843/JBN.2026.v10.i02.p05

INTRODUCTION

The human hand is a specialized organ responsible for fine motor function, sensation, and complex manipulation tasks. Despite representing a small proportion of total body surface area, the hand is frequently affected in burn injuries, leading to significant functional disability if not adequately treated. Burn-related hand deformities and contractures remain a major challenge in reconstructive surgery and require a detailed understanding of hand anatomy and biomechanics.[3,4]

Post-burn contractures can involve skin, fascia, tendons, ligaments, joint capsules, and bone, resulting in deformities that significantly impair hand function. Therefore, reconstructive surgeons must understand the intricate anatomy of the hand to perform optimal surgical intervention and prevent recontracture.[3,13]

METHODS

This narrative literature review was conducted using anatomy textbooks, StatPearls articles, and plastic surgery

references, focusing on hand anatomy, biomechanics, contracture pathophysiology, and reconstructive surgical techniques. The included literature provided anatomical, clinical, and surgical perspectives relevant to burn reconstruction and hand contracture management.[1-14]

RESULTS AND DISCUSSION

General Anatomy of the Hand

The hand is composed of integumentary structures, skeletal components, muscles, tendons, nerves, and vascular systems that function together to enable precise movements. The skeletal framework consists of metacarpals, phalanges, and sesamoid bones, forming metacarpophalangeal and interphalangeal joints that allow complex motion patterns.[4,5]

Extrinsic muscles originate from the forearm and control gross movements, while intrinsic muscles provide fine motor control and precision grip. Neural innervation is primarily provided by the median, ulnar, and radial nerves, and vascular supply is derived from arterial arches and digital vessels.[4,10,11]

Skin, Subcutaneous Tissue, and Fascia

There are significant differences between the characteristics of the skin and soft tissues covering the dorsal and palmar aspects of the hand. The dorsal hand skin is thin and pliable and is attached to the deep fascia by loose areolar tissue. These characteristics, together with the fact that most venous and lymphatic drainage originates from the dorsal aspect, make superficial veins easily visible and useful for clinical assessment of venous filling and extremity venous pressure. However, this also makes the dorsal hand particularly vulnerable to avulsion injuries.[4]

In contrast, the palmar skin is characterized by a thick dermal layer and a robust keratinized epithelial surface. It is firmly anchored to the palmar fascia by vertical fibrous septa distributed diffusely between the fascia and dermis. The stability of palmar skin is essential for hand function, and scar fixation or loss of elasticity can result in contracture and functional impairment. The palmar skin is also rich in specialized sensory receptors and sweat glands.[4]

Surgeons must understand the relationship between palmar skin creases and the underlying joints to plan appropriate skin incisions for joint and structural exposure. Examination of the skin throughout the normal range of motion is critical to prevent scar contracture that may restrict movement. On the palmar aspect, longitudinal inelastic scars can limit finger extension; therefore, reconstruction should preserve the diamond-shaped elastic skin pattern of the palm.[4]

The palmar fascia consists of dense fibrous tissue arranged in longitudinal, transverse, oblique, and vertical fibers. Longitudinal fibers originate primarily from the palmaris longus tendon and extend into the digits, attaching to the fibrous flexor sheaths. Transverse fibers form the transverse palmar ligament, which functions as a pulley for flexor tendons, while vertical fibers form septa that create compartments for flexor tendons and neurovascular bundles. In the fingers, two important fascial structures are the Grayson ligament, located volar to the neurovascular bundle, and the Cleland ligament, located dorsally and more robust. These ligaments stabilize and protect the digital neurovascular structures.[4]

Bones and Joints

The skeletal framework of the hand consists of five metacarpal bones, fourteen phalanges, and four sesamoid bones. This structure forms the basis for the functional complexity of the hand.[5] The first metacarpal articulates with the thumb, while the second

through fifth metacarpals articulate with the index, middle, ring, and little fingers, respectively. Distally, each metacarpal articulates with the proximal phalanx to form the digits.[5,6]

The thumb contains two phalanges, whereas the other digits contain three phalanges (proximal, middle, and distal). The proximal and middle phalanges have two condyles at the head, while the distal phalanx ends in a tuft protected dorsally by the nail plate.[5–7]

Hand joints include the metacarpophalangeal (MP), proximal interphalangeal (PIP), distal interphalangeal (DIP), and interphalangeal (IP) joints of the thumb. These joints possess capsular and collateral ligaments that allow flexion, extension, and, at the MP joints, abduction and adduction.[6]

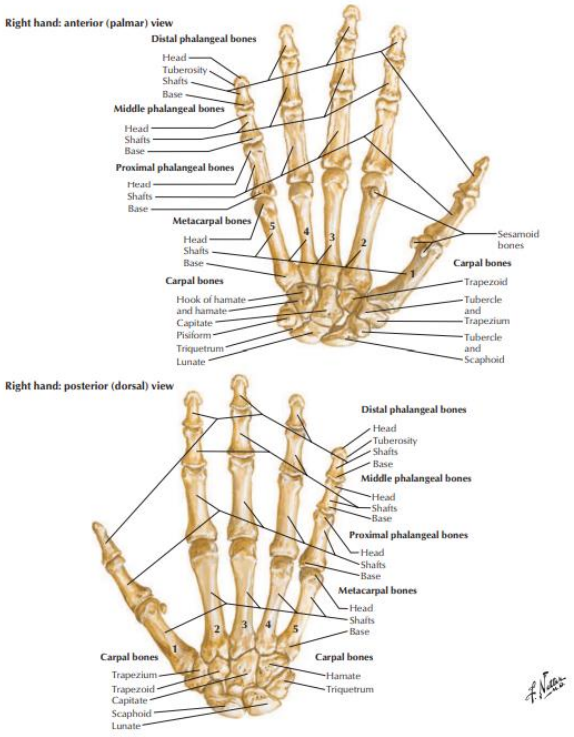


Figure 1. Skeletal framework of the hand.[8]

Muscles

Hand muscles are classified into extrinsic and intrinsic muscles. Extrinsic muscles originate in the forearm and insert into the hand, whereas intrinsic muscles originate and insert within the hand. The anterior flexor group includes the flexor carpi radialis, flexor carpi ulnaris, flexor digitorum superficialis, palmaris longus, and flexor digitorum profundus, which are responsible for wrist and finger flexion. The posterior extensor group includes the extensor carpi radialis longus and brevis, extensor carpi ulnaris, extensor digitorum, extensor digiti minimi, and extensor indicis, which produce wrist and finger extension.[6]

Intrinsic hand muscles include the hypothenar muscles, dorsal and palmar interossei, and lumbricals, which are essential for fine motor control and coordinated finger movements. Thumb musculature consists of extrinsic and intrinsic muscle groups forming the thenar eminence and enabling opposition, a critical function for precision grip.[5,6]

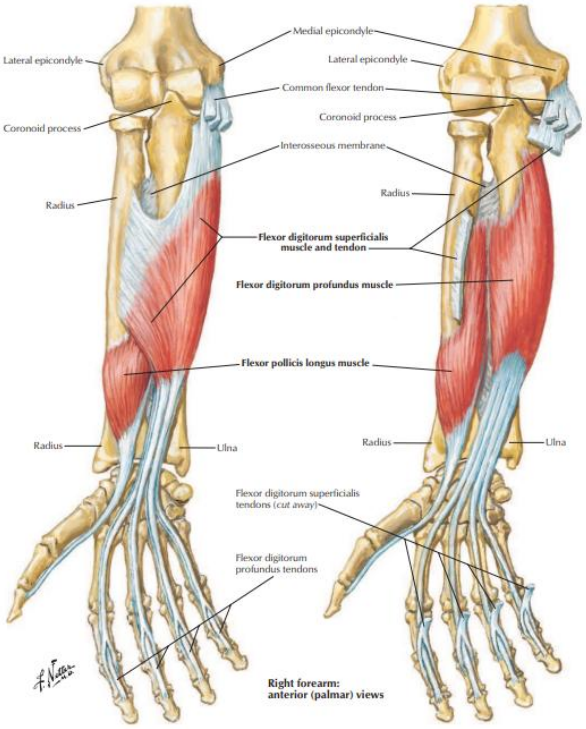


Figure 2. Extrinsic hand muscle, anterior view.[8]

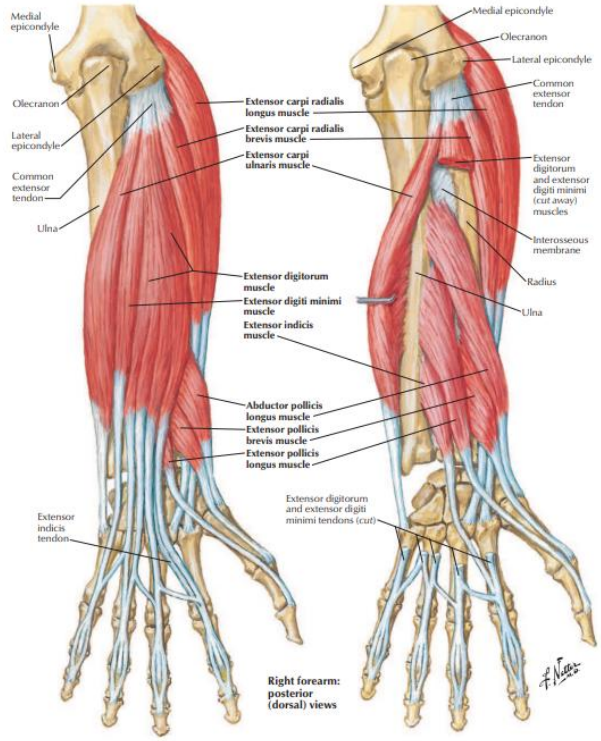


Figure 3. Extrinsic hand muscle, posterior view.[8]

Innervation

Hand innervation is provided by the median, ulnar, and radial nerves. The median nerve supplies the volar aspect of the lateral three and a half digits, the ulnar nerve supplies the fourth and fifth digits, and the radial nerve supplies the dorsal aspect of the hand. Understanding this distribution is essential for evaluating sensory and motor function.[5]

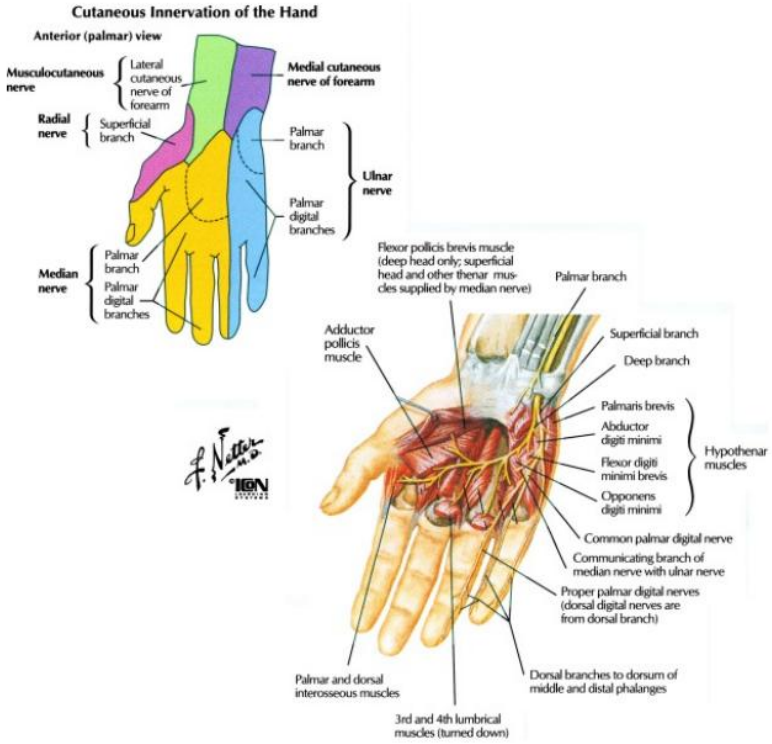


Figure 4. Cutaneous innervation of hand, anterior (palmar) view.[9]

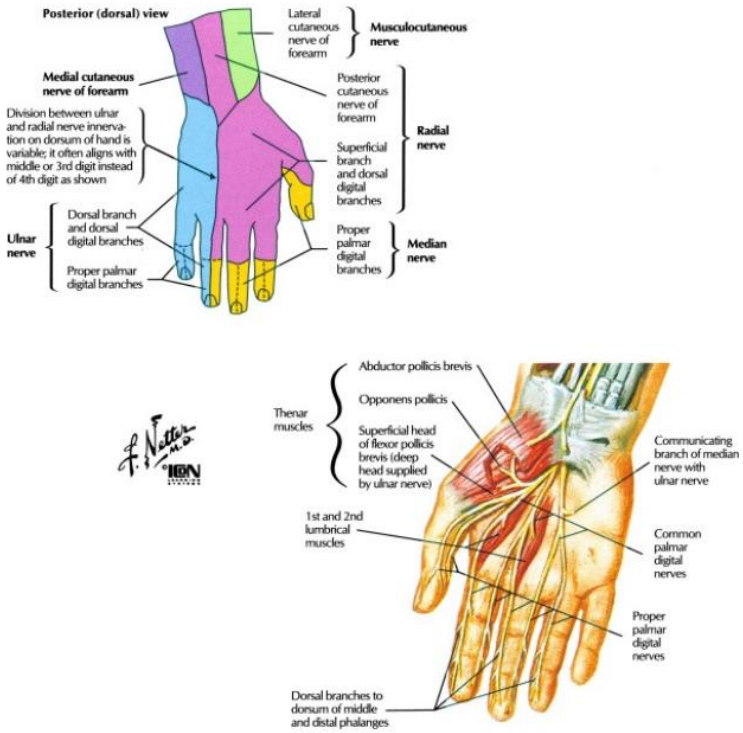


Figure 5. Cutaneous innervation of hand, dorsal view.[9]

Vascularization

The vascular system of the hand includes arteries, veins, and capillaries that supply oxygen and nutrients to tissues. The main arterial supply to the upper extremity includes the subclavian, axillary, brachial, radial, and ulnar arteries. The radial and ulnar arteries form the superficial and deep palmar arches, which supply the digits.[6]

The venous system consists of deep veins accompanying arteries and superficial veins such as the cephalic, basilic, and median cubital veins, which are commonly used for clinical venous access.[6]

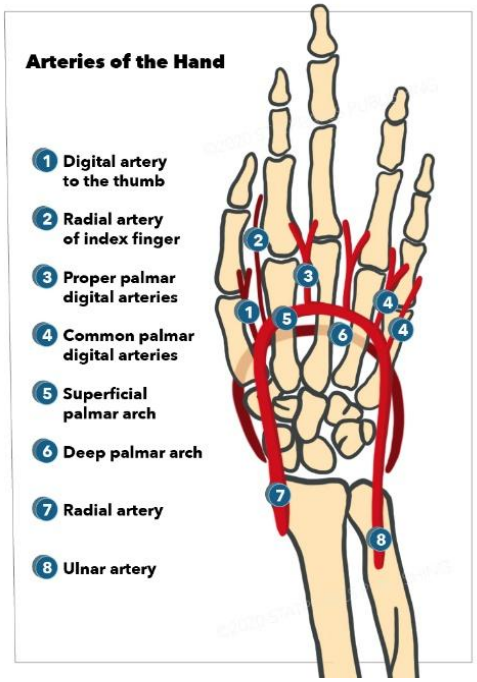


Figure 6. Schematic view of arteries of the hand.[10]

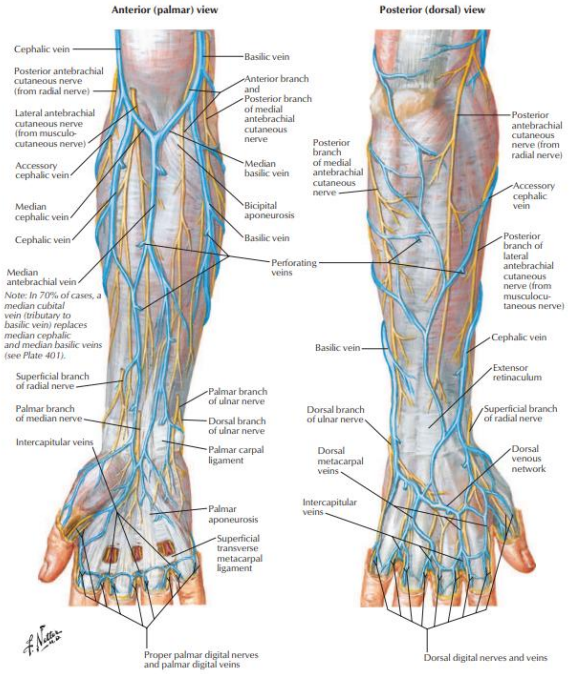


Figure 7. Vascularization of the manus and antebrachial veins, anterior and posterior views.[8]

Lymphatic System

Lymphatic drainage of the hand originates from lymphatic capillaries in the distal fingers and palm, courses along the dorsal hand and forearm, and ultimately drains into the lateral axillary lymph nodes. This system plays a critical role in immune response and wound healing.[11]

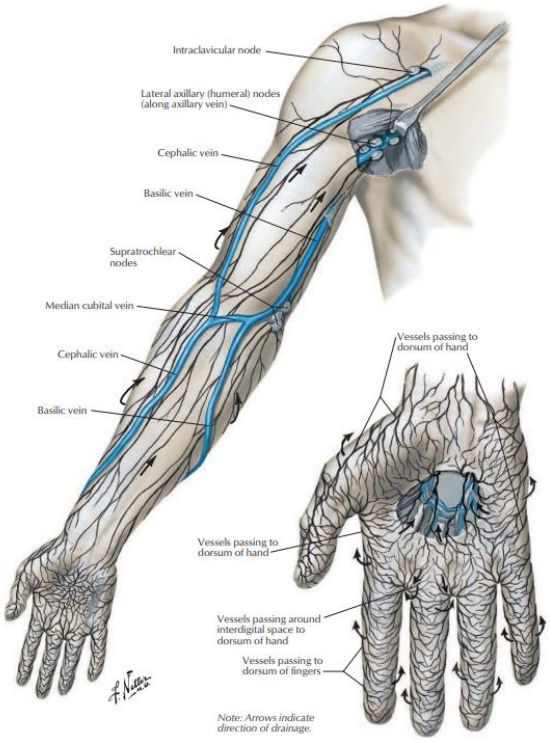


Figure 8. Lymphatic drainage of the hands.[8]

Surgical Anatomy of the Hand

Dorsal Approach

The dorsal approach provides access to metacarpals, MCP joints, PIP joints, phalanges, and DIP joints, and is widely used in trauma and reconstructive surgery.[12]

Metacarpals: Metacarpals are exposed via longitudinal dorsal incisions, with careful preservation of superficial radial and ulnar sensory nerve branches. Access is obtained through the interosseous raphe, which can be repaired to improve stability and hemostasis.[12]

Metacarpophalangeal Joint: The MCP joint is approached by splitting the extensor tendon longitudinally while preserving the sagittal bands to avoid tendon instability. The joint capsule is incised longitudinally for exposure.[12]

Proximal Interphalangeal Joint: The PIP joint can be accessed between the central slip and lateral bands or through a midline approach, depending on surgical goals. Midline approaches provide superior exposure for arthrodesis.[12]

Proximal and Middle Phalanges: The dorsal approach allows direct access to the phalangeal shafts but may result in postoperative extensor lag due to tendon adhesion.[12]

Distal Interphalangeal Joint: The DIP joint can be exposed using H-shaped or transverse incisions for arthrodesis or oblique incisions when joint preservation is desired.[12]

Palmar Approach

Carpal Tunnel: A curved longitudinal incision parallel to the thenar eminence avoids injury to the palmar cutaneous branch of the median nerve. Palmar fascia and flexor retinaculum are incised to expose the carpal tunnel.[12]

Palmar Mid and Distal Hand: Zig-zag incisions provide access for fasciectomy, with careful preservation of neurovascular bundles.[12]

A1 Pulley: The A1 pulley is accessed through transverse, oblique, or longitudinal incisions, maintaining a midline approach to protect digital neurovascular structures.[12]

Thumb A1 Pulley: Thumb A1 pulley release requires careful dissection due to the proximity of digital nerves, especially during MCP joint extension.[12]

Digits: Midline palmar incisions with Z-plasty allow access to the flexor mechanism while preserving lateral neurovascular bundles.[12]

Z-Plasty: Z-plasty is a random-pattern flap technique that increases incision length and changes scar direction, with 60-degree Z-plasty providing approximately 75% lengthening.[12]

Proximal Phalanx Base: Palmar access to the proximal phalanx base and MCP joint is achieved through angled incisions, protecting digital nerves and exposing the palmar plate.[12]

Terminal Phalanx and Nail Bed: Longitudinal midline or fish-mouth incisions provide access to the distal phalanx and nail bed, with nail plate removal facilitating matrix exposure.[12]

Lateral Approach

Mid-Lateral Approach: The mid-lateral approach exposes the shaft and condyles of the proximal and middle phalanges while preserving dorsal digital nerve branches.[12]

Thumb MCP Joint: Ulnar and radial S-shaped incisions provide access to collateral ligaments, with careful dissection of the adductor aponeurosis and abductor pollicis brevis.[12]

Hand Contractures

Flexion Contracture

Flexion contractures result from shortening of palmar structures such as skin, fascia, flexor tendon sheath, and tendons. Dupuytren's contracture is a classic example of fascial contracture. Volar plate contraction occurs early in interphalangeal joint contractures. Bone blocks and dorsal adhesions may also restrict joint extension.[13]

Extension Contracture

Extension contractures result from the tightening of dorsal joint structures, including skin, extensor tendons, joint capsule, and collateral ligaments. Intrinsic muscle fibrosis and flexor tendon adhesions can further limit joint motion.[13]

Burn-Related Hand Contractures and Deformities

Boutonniere Deformity

Boutonniere deformity is characterized by PIP flexion and DIP hyperextension due to central slip rupture and triangular ligament injury. Burn-related ischemia and dorsal capsule injury may contribute to this deformity. Conservative management includes splinting and physiotherapy, while surgical intervention is required for severe tendon or bone injury.[14]

Claw Deformity

Claw deformity involves MCP hyperextension and IP flexion and is one of the most difficult deformities to reconstruct. Surgical management may include collateral ligament release, capsulotomy, palmar plate release, and flap coverage, particularly in pediatric patients.[3]

Palmar and Finger Flexion Contracture

Flexion contractures are classified into Type I (skin), Type II (palmar capsule), and Type III (joint fixation). Management includes contracture release, full-thickness skin grafting, flap coverage, and joint fixation depending on severity.[3]

Web Space Syndactyly

Post-burn syndactyly results from digit fusion during healing. Surgical correction includes Z-plasty and its modifications, often combined with skin grafting or free flap reconstruction in severe cases.[3]

Management of Hand Contractures

PIP Joint Flexion Contracture

Management includes Z-plasty incisions, cross-finger or island flaps, checkrein ligament release, flexor tenolysis, and collateral ligament release to restore extension.[13]

PIP Joint Extension Contracture

Dorsal curvilinear incisions provide exposure for capsulotomy and extensor tendon release. Collateral ligament division may be required in severe fibrosis.[13]

MCP Joint Extension Contracture

Dorsal capsulotomy and collateral ligament release restore joint flexion. Volar plate release and management of jump phenomenon are also required.[13]

CONCLUSION

The hand is a complex anatomical organ with integrated integumentary, musculoskeletal, neural, and vascular systems. Burn injuries frequently result in contractures and deformities that require reconstructive surgery. Detailed knowledge of surgical anatomy and contracture pathophysiology is essential for selecting appropriate surgical approaches and reconstruction techniques. Understanding these principles improves functional and aesthetic outcomes in burn reconstruction.[3,13]

ACKNOWLEDGEMENT

The authors would like to thank the staff of the Plastic, Reconstructive, and Aesthetic Surgery Division, IGNG Ngoerah General Hospital, Denpasar, for their support during the preparation of this manuscript.

DISCLOSURE

The authors declare no conflict of interest related to this study.

REFERENCES

1. Haughton D, Jordan D, Malahias M, Hindocha S, Khan W. Principles of hand fracture management. Open Orthop J. 2012;6:43–53.
2. Sridhar R, Hariharan NC. Reconstruction of post-burn contracture of fingers. Int J Sci Study. 2017;5(2):55–58.
3. Son D. Correction of hand deformities after burns. Arch Hand Microsurg. 2022;27(1):12–22.
4. Chang J, Valero-Cuevas F, Hentz VR, et al. Anatomy and biomechanics of the hand. In: Neligan PC, editor. Plastic Surgery. 3rd ed. London: Elsevier; 2013.
5. Arias DG, Varacallo M. Anatomy, shoulder and upper limb, hand bones. StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
6. Purnomo E. Anatomi fungsional. Yogyakarta: Lintang Pustaka Utama; 2019.
7. McDaniel D, Rehman U. Phalanx fracture of the hands. StatPearls.

Treasure Island (FL): StatPearls Publishing; 2022.
8. Netter FH. Netter's atlas of human anatomy. 7th ed. Philadelphia: Elsevier; 2019.
9. Thompson JC. Netter's concise atlas of orthopaedic anatomy. Philadelphia: Saunders Elsevier; 2002.
10. Nguyen J, Duong H. Anatomy, shoulder and upper limb, hand arteries. StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
11. Okwumabua E, Sinkler MA, Bordoni B. Anatomy, shoulder and upper limb, hand muscles. StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
12. Giddins GEB, Shewring DJ. Wrist and hand. In: Brennan PA, Standring SM, Wiseman SM, et al. Gray's Surgical Anatomy. Elsevier; 2020.
13. Netscher DT. The stiff hand and the spastic hand. In: Neligan PC, editor. Plastic Surgery. 3rd ed. London: Elsevier; 2013.
14. Binstead JT, Tafti D, Hatcher JD. Boutonniere deformity. StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.