

Hand Reconstructive Surgery Current Indications

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ABSTRACT

Hand reconstructive surgery encompasses a broad range of techniques aimed at restoring form and function following trauma, burns, tumor excision, or congenital malformations. The reconstructive strategy is guided by the extent of tissue loss and exposure of critical structures, progressing along the reconstructive ladder from simple skin grafts to complex microvascular free flaps. Key indications include post-traumatic defects, burn contractures, complex fractures, inflammatory arthropathies, and soft tissue loss with exposed bone, tendon, or neurovascular elements. Modern microsurgical techniques, such as free tissue transfer and toe-to-hand transplantation, have greatly enhanced functional restoration, particularly in mutilating injuries. Successful outcomes require a multidisciplinary approach integrating surgical precision with postoperative rehabilitation to optimize mobility, strength, and dexterity. Overall, hand reconstruction aims not only to restore essential hand function but also to preserve aesthetic integrity and improve quality of life.

KEYWORDS: hand reconstruction, microsurgery, flap coverage, trauma, burns, free tissue transfer, functional restoration, reconstructive ladder

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INTRODUCTION

Microsurgery in plastic and reconstructive surgery encompasses the use of specialized instruments and magnification to perform precise operations on small anatomical structures, particularly blood vessels and nerves. Its principal applications include free tissue transfer (free flaps), nerve repair, replantation of amputated parts, and lymphatic surgery.[1-5] Free tissue transfer has become a cornerstone of modern reconstructive surgery, enabling the restoration of complex defects in the head and neck, extremities, breast, and craniofacial regions by transplanting vascularized tissue from distant sites and reestablishing circulation via microvascular anastomoses.[5-7] Recent advances have focused on perforator flaps, which minimize donor site morbidity by preserving underlying muscle and function, and on the development of “freestyle” flaps that allow for patient-specific, customized reconstruction based on detailed anatomical knowledge.[2][4] Supermicrosurgery, defined as the manipulation of vessels and nerves with diameters as small as 0.3–0.8 mm, has expanded the scope of lymphatic surgery

and enabled minimally invasive, functionally superior reconstructions, particularly in the management of cancer-related lymphedema.[1][3][8] Technological innovations have further enhanced microsurgical outcomes. Robotic-assisted microsurgery, using platforms such as the da Vinci and MUSA systems, has improved precision and reduced operative times, while advanced imaging modalities—including MR lymphography and near-infrared fluorescence—have optimized preoperative planning and intraoperative decision-making.[1] Composite tissue allotransplantation, such as face and limb transplantation, represents a frontier in reconstructive microsurgery, combining technical expertise with immunological management to restore both form and function in patients with devastating injuries.[3][6-7] Microsurgical success depends on meticulous technique, appropriate patient selection, and rigorous perioperative management, including flap monitoring and thrombolytic therapy when indicated.[5] The continuous evolution of microsurgical methods, including the integration of artificial

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intelligence and robotics, promises further improvements in precision, efficiency, and patient outcomes.[1-2]

Indications

1. Post-traumatic defects and mutilating injuries: These encompass complex soft tissue loss, digital amputations, and mangled hands resulting from industrial, agricultural, household, or combat-related trauma. The primary surgical goals are restoration of prehensile function, preservation of thumb and at least two sensate digits, and coverage of exposed vital structures. Salvage procedures are considered when basic hand function can be maintained, with special emphasis on thumb preservation due to its critical role in opposition and grip strength.[1-2]

2. Burn contractures: Patients with hand burns may develop contractures, particularly involving the first web space and the little finger, which limit range of motion and function. Surgical release of contractures and flap coverage are frequently required to restore hand mobility and prevent further deformity. The need for reconstructive surgery is higher in cases with extensive full-thickness burns and those requiring acute surgical intervention.[3]

3. Fractures with complex features: Hand fractures that are comminuted, intra-articular, associated with significant angulation ($>15^\circ$), dislocation (>4 mm), or involve multiple digits, as well as those with concomitant tendon, nerve, or vessel injury, often necessitate surgical intervention for anatomical restoration and functional recovery.[4]

4. Rheumatoid arthritis and other inflammatory arthropathies: Chronic synovitis and joint destruction can lead to deformities such as ulnar deviation, swan-neck, and boutonnière deformities. Indications for surgery include persistent pain despite optimal medical management, functional impairment, and patient desire for improved hand appearance. Surgical options range from soft tissue procedures for reducible deformities to arthroplasty or arthrodesis for irreducible or structurally damaged joints.[5-6]

5. Soft tissue defects: Reconstruction is indicated for defects exposing bone, tendon, or neurovascular structures, especially when local tissue is insufficient for coverage. Free flaps are preferred for large defects (>3 cm), while local flaps are used for smaller defects. Restoration of thumb and at least two fingers is prioritized for functional outcomes; reconstruction of single distal finger defects is generally considered cosmetic unless sensibility or tip function is compromised.[7]

6. Pediatric and special scenarios: In children under 2 years, certain pedicled flaps may be indicated for complex defects. Other specific indications include high-voltage electrical burns with compromised vascular supply, salvage of thumb ray, and preservation of length in multiple digital amputations, particularly in manual workers.[2]

These indications reflect the need to restore function, prevent further disability, and optimize hand aesthetics, with surgical

decision-making tailored to the extent of injury, patient needs, and available reconstructive options.

Conclusion

Hand reconstructive surgery represents a cornerstone of functional and aesthetic restoration in patients with traumatic, oncologic, congenital, or burn-related hand defects. Successful reconstruction relies on individualized surgical planning guided by the reconstructive ladder, selecting the simplest effective technique to achieve durable coverage, preserve vital structures, and restore motion and sensibility. Advances in microsurgery, including free tissue transfers and toe-to-hand transplants, have significantly expanded reconstructive possibilities, enabling restoration of complex prehensile functions and improving quality of life. Optimal outcomes require a multidisciplinary approach integrating surgical expertise with postoperative rehabilitation, physiotherapy, and occupational therapy. Ultimately, timely, tailored reconstruction not only salvages limb function but also preserves the patient's autonomy, dexterity, and psychosocial well-being.

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