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The Hierarchy of Needs: A Problem-based Framework for Extremity Reconstruction

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Summary: Plastic and reconstructive surgeons continually evolve their surgical strategies with the aim of achieving the optimal patient outcome. Numerous well-known frameworks intended to guide reconstructive planning have been introduced and are entrenched in plastic surgery education, but are limited in their scope due to their procedure-based construct. Here, we introduce the hierarchy of reconstructive needs: a problem-based reconstructive framework that shifts operative planning to the specific needs of the defect and goals for restoration of normality while allowing for further innovation and evolution beyond our existing surgical capabilities. *(Plast Reconstr Surg Glob Open 2024; 12:e6037; doi: 10.1097/GOX.0000000000006037; Published online 7 August 2024.)*

Humans are innately curious beings. Curiosity stimulates exploration and fuels motivation, both of which are critical to success in any medical profession. In his 1943 work titled, “A Theory of Human Motivation,” Abraham Maslow introduced a five-tier hierarchy of fundamental human needs as a framework to understand human motivation: psychological needs, safety needs, needs of love and belonging, self-esteem needs, and the need for self-actualization[1] (Fig. 1). His framework proposes that our innate motivation begins with meeting basic needs, such as food, water, and shelter, and moves toward fulfillment of higher-order needs, such as employment, friendship, and self-esteem. Although needs in different tiers may exist concurrently, humans prioritize needs of deficiency, or those in lower tiers, before acknowledging higher-level growth needs.

Just as humans naturally seek fulfillment of higher-order needs, plastic surgeons have continually evolved surgical strategies and techniques with the aim of achieving the optimal patient outcome. For the reconstructive surgeon, perfection is rooted in restoration of normality, driven by commandments from Gillies and Millard that state “know the ideal beautiful normal,” “honor that which is normal and return it to normal position,” and “tissue losses should be replaced in kind.”[2–4] Self-actualization is achieved when a defect’s full potential has been realized, or when the defect has “become everything [it is] capable of becoming.”[1,5]

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Our intrinsic motivation to advance reconstructive efforts in pursuit of self-actualization has been undercut by reconstructive frameworks that are inherently limited in their imagination and scope. Although intended to ease the process of developing a reconstructive plan, the existing reconstructive frameworks largely emphasize the application of specific surgical techniques over the understanding of conceptual goals outlined by our reconstructive forebearers. Perhaps the most well-known is the reconstructive ladder, which ranks methods of reconstruction in order of complexity and advocates for the simplest possible choice to achieve wound closure.[6] The prioritization of technical simplicity comes at the cost of fully identifying the needs of the defect, thus condemning the reconstruction to fall short of self-actualization. Over time, the reconstructive ladder has been expanded, altered, and reshaped in an attempt to incorporate increasingly complex, modern reconstructive approaches.[7–13] Whether climbing an expanded ladder, riding the elevator, or navigating a matrix or supermarket, clinical application of these procedurally-based frameworks is plagued by the lack of conceptual guidance necessary to compare reconstructive strategies or optimize the selected surgical technique. For example, it is common for surgeons to take the “reconstructive elevator” to the top floor, by selecting a complex microsurgical procedure, only to go through the “wrong door” by selecting a reconstruction that fails to adequately meet the needs of the defect.

Despite the dramatic advance in our reconstructive capabilities since the introduction of the reconstructive ladder more than 40 years ago, the ladder remains pervasive throughout training programs and in practice today. It has also been adopted by other specialties as a means to understand our capabilities and contribution to care. Because it fails to provide a framework by which to value or compare various reconstructive techniques, it has also served as a

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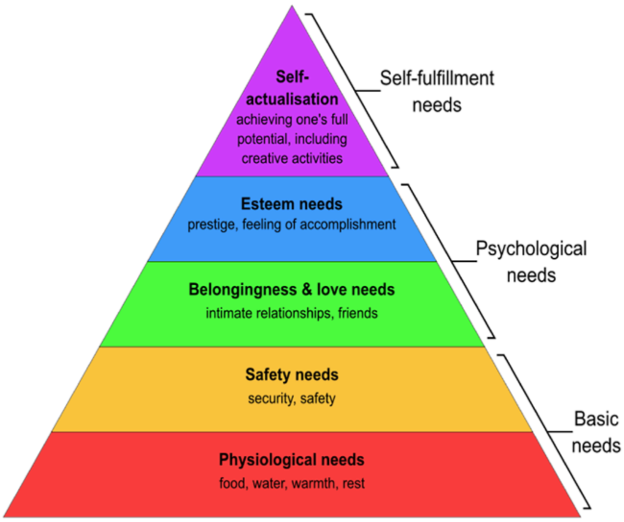

Fig. 1. Abraham Maslow's hierarchy of fundamental human needs.[1]

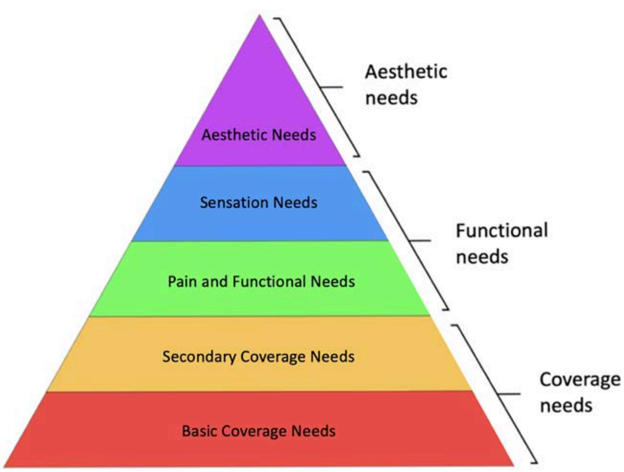

Fig. 2. The hierarchy of reconstructive needs.

Takeaways

Question: How can we optimize reconstructive planning to reach the most comprehensive, problem-based plan that most closely resembles normal anatomy?

Findings: The hierarchy of needs is a reconstructive framework that is problem-based rather than procedure-based, thus allowing reconstructive planning to be guided by the specific needs of the defect. The ultimate result of a reconstructive plan as guided by this framework is a plan that most closely restores normal form and function in all aspects.

Meaning: Operative planning should be guided by a framework that is based on the reconstructive problem at hand and can adapt to further innovation in plastic surgery.

mechanism for encroachment into the plastic surgeon's previous domain, as virtually all surgeons are capable of providing the reconstructions represented by the ladder's lowest rungs. As our surgical armamentarium grows and the goals of reconstruction become loftier, the framework must be able to adapt. The reconstructive ladder, like any construct built on procedures, is inherently limited to the reconstructive strategies of the present. It can be expanded and addended,[7,8,14] but only *after* new reconstructive techniques have been developed. It does not drive us to develop new techniques or strategies in the pursuit of optimal form and function. An entirely new mindset is needed to better define our goals and foster progress toward them.

THE HIERARCHY OF RECONSTRUCTIVE NEEDS

Adapted from Maslow's hierarchy of human needs, the hierarchy of reconstructive needs identifies three major goals to be met by a reconstructive plan: critical coverage needs, functional needs, and aesthetic needs (Fig. 2). The framework is defect focused rather than procedurally focused, shifting the crux of operative planning to the

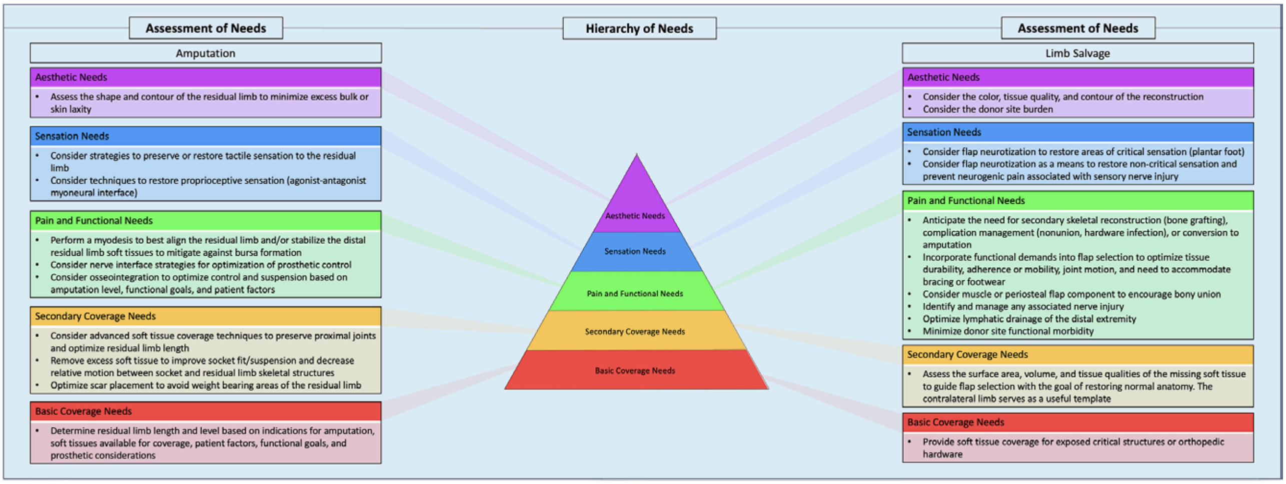

Fig. 3. The hierarchy of reconstructive needs applied to clinical practice in amputation (left) and limb salvage (right).

needs of the defect and goals for restoration of normal rather than the selection of a given surgical technique. As in Maslow's original framework, lower-level needs are most critical and must be addressed before advancing toward higher-level needs. By focusing on the needs of the defect, the hierarchy framework allows room for evolution beyond our existing surgical capabilities. The ideal reconstruction, or one that meets all levels of needs, will naturally mimic normal form and function as closely as possible and may offer the possibility of improved function and appearance compared with that of native tissue.

Coverage Needs

The most elementary aspect of an effective reconstructive plan is detailed analysis of the problem. Assessment of basic coverage needs can be summarized in two complementary questions: what is not present that should be, and what is present that should not be? A basic soft tissue coverage strategy should mitigate the risk of infection and provide effective coverage for exposed critical structures such as denuded bone, critical neurovascular structures, and hardware. After determining the presence of exposed critical structures, attention is

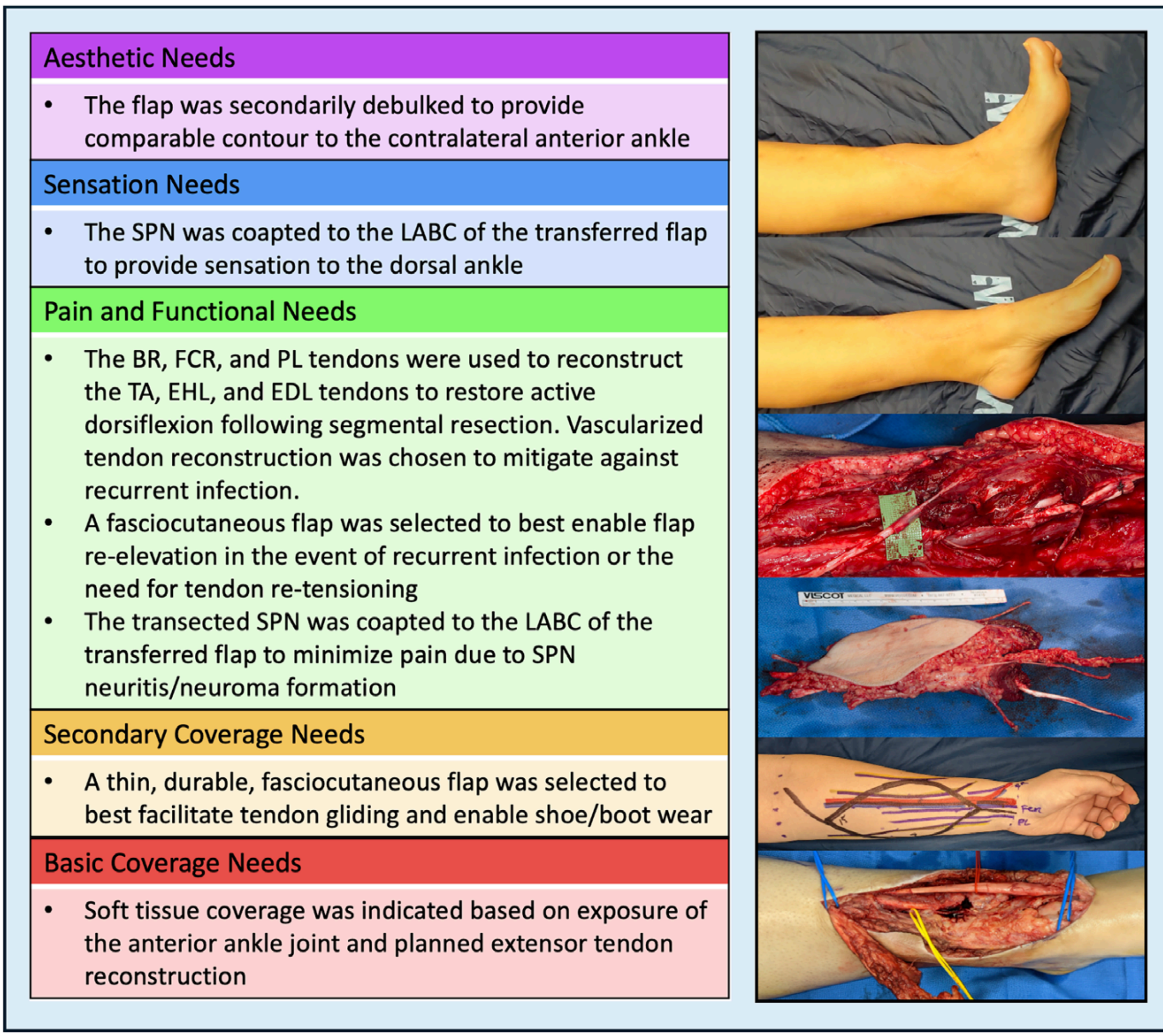

Fig. 4. A 41-year-old woman who sustained a severe laceration of her left ankle extensor tendons requiring tendon repair and grafting complicated by soft tissue loss and infection of the tendon repair. After a lengthy period of wound care and infection management, she ultimately elected to undergo resection of the involved extensor tendons and necrotic soft tissue resulting in a large anterior ankle defect and complete foot drop. She underwent reconstruction with a composite left radial forearm flap and brachioradialis, flexor carpi radialis, and palmaris longus tendon for reconstruction of the tibialis anterior, extensor hallucis longus, and extensor digitorum longus tendons, respectively. The flap skin paddle was neurotized via coaptation of the transected superficial peroneal nerve to the lateral antebrachial cutaneous nerve to provide sensation. The patient achieved full strength and range of motion following the reconstruction. SPN, superficial peroneal nerve; LABC, lateral antebrachial cutaneous nerve; BR, brachioradialis; FCR, flexor carpi radialis; PL, palmaris longus; TA, tibialis anterior; EHL, extensor hallucis longus; EDL, extensor digitorum longus.

turned to absent structures. Secondary coverage needs are defined in terms of surface area, volume, tissue type, and tissue qualities. Careful analysis of a defect's missing tissue enables formulation of a reconstructive plan that pays homage to Gillies and Millard's 15th executional principle, "tissue losses should be replaced in kind."[4] To that end, the uninjured limb and contralateral face or trunk serve as the perfect aid for understanding tissue needs. Although patient factors or logistical constraints may prevent execution of the optimal reconstruction, it is nonetheless worth defining this ideal, lest we become content with suboptimal reconstructions in the absence of these barriers.

Functional Needs

Determination of the functional needs of a defect requires a holistic and longitudinal analysis of the reconstruction over time. This begins with identification of additional factors within the defect that may require future staged procedures, such as secondary skeletal, tendon, or nerve reconstruction. If re-entry into the wound base for staged procedures is anticipated, the strategy for soft tissue reconstruction should enable facile flap elevation in a delayed fashion. Certain cases may be at higher risk of unexpected complications requiring operative intervention; this is of particular concern when soft tissue and bony reconstruction are needed concomitantly. In cases with

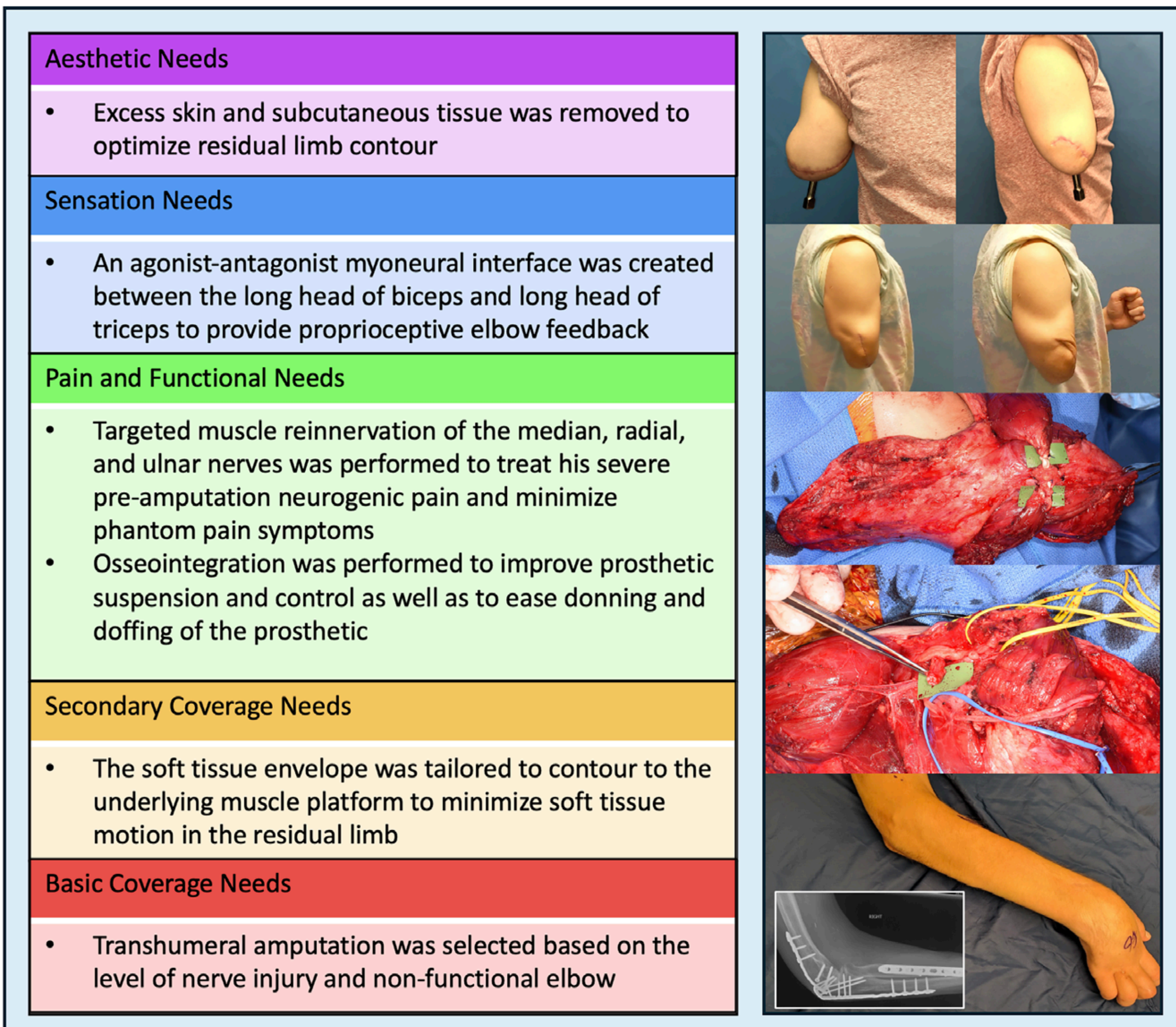

Fig. 5. A 22-year-old man who sustained a severe right upper extremity injury due to a boating accident that resulted in large segmental injuries to the median, ulnar, and radial nerves with subsequent traumatic arthrodesis of the right elbow. He presented 18 months after injury, seeking amputation of the insensate, nonfunctional right upper extremity. He underwent a transhumeral amputation with targeted muscle reinnervation and agonist-antagonist myoneural interface procedures. He subsequently underwent osseointegration for direct skeletal attachment of his right upper extremity prosthesis. The patient reports manageable phantom pain symptoms and is an active prosthetic user.

a significant likelihood of unplanned secondary procedures, such as a bony nonunion, heterotopic ossification, or hardware infection, re-elevation of the soft tissue reconstruction will become necessary and should be anticipated in the original reconstruction. The selected plan should mirror the compliance and durability of the surrounding tissues to facilitate normal anatomic behavior after healing is complete. Limb motion, tendon gliding, exposure to friction or pressure, and ability to withstand minor trauma are factors that should be considered on this level of the framework. Plans for postoperative radiation therapy must be considered, as its effect may compromise high-order function due to increased scarring and fibrosis and may limit ability to re-enter the defect secondarily. A complete assessment of motor and sensory nerve function should be performed, paying particular attention to the location of any transected nerve ends or neuromas. Strategies for prevention or treatment of neuropathic pain and restoration of sensation may improve the overall function of the reconstruction.

Aesthetic Needs

Once basic coverage and functional needs have been met, the highest order reconstruction focuses on the aesthetic components of the reconstruction. This is a familiar discussion in breast reconstruction, which is intrinsically

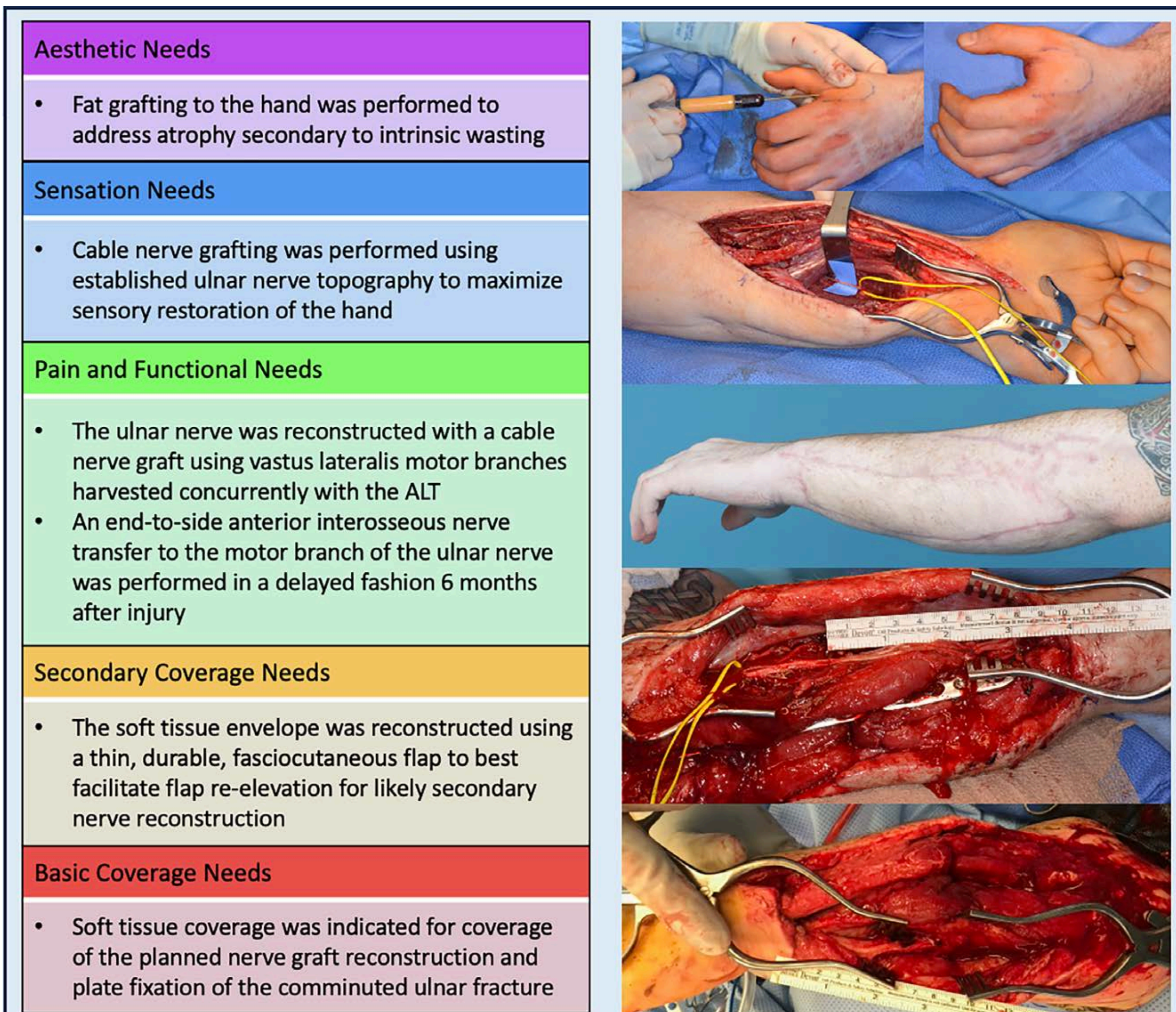

Fig. 6. A 28-year-old man who sustained a severe blast injury to the left ulnar forearm. The blast resulted in a large soft tissue defect, severely comminuted ulnar fracture, and segmental ulnar nerve injury. He underwent open reduction internal fixation of the ulna with concomitant reconstruction of the soft tissue defect using a contralateral anterolateral thigh flap and harvest of vastus lateralis motor nerve branches for multiple-strand nerve graft reconstruction of the ulnar nerve. Six months after injury and initial reconstruction, he underwent an end-to-side anterior interosseous nerve transfer to the motor branch of the ulnar nerve distal to the site of injury and fat grafting of the hand to address atrophy secondary to intrinsic wasting.

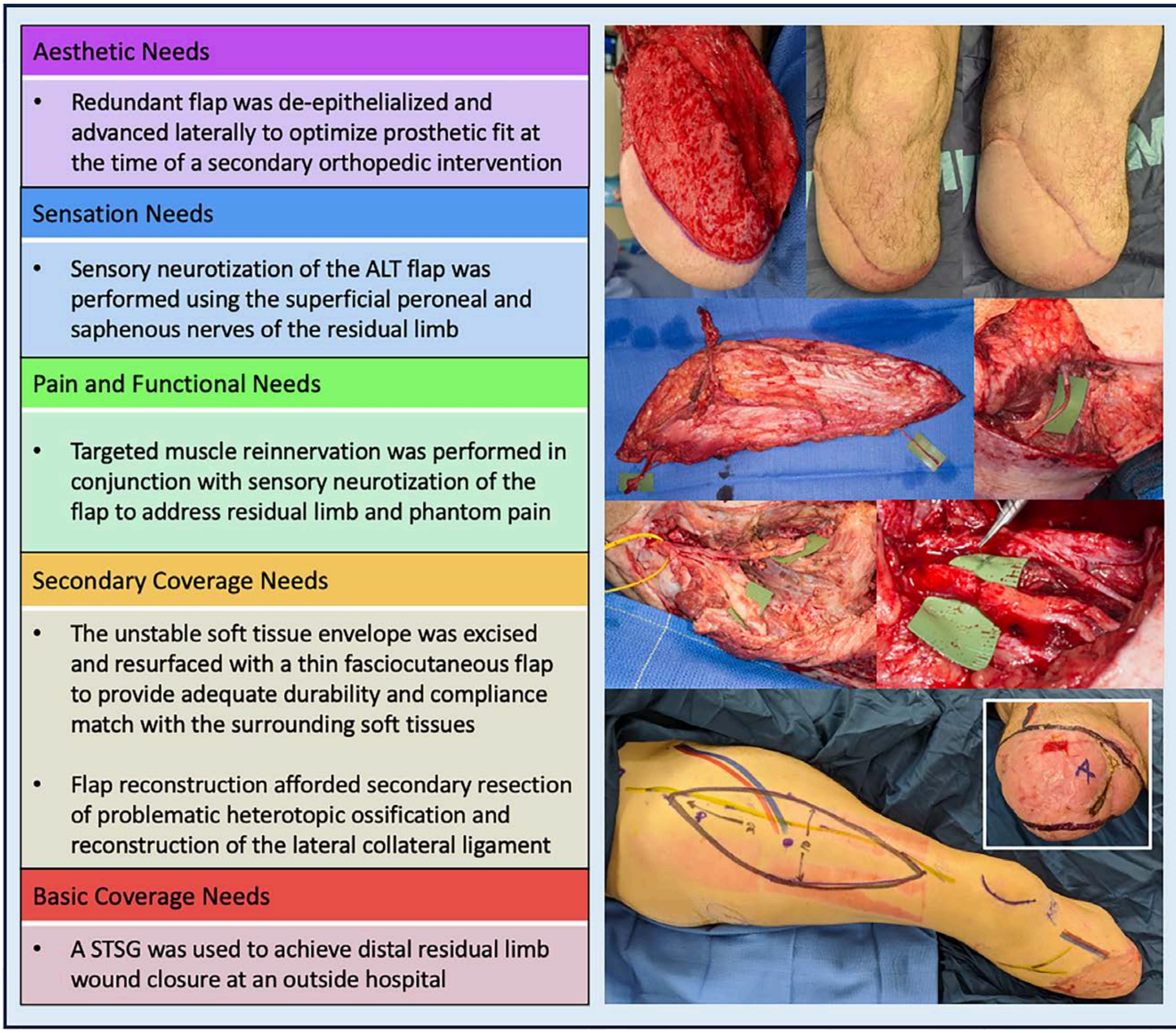

Fig. 7. A 58-year-old man with a traumatic right below-knee amputation secondary to a motorcycle accident who presented with an inability to weight-bear in a prosthetic due to an unstable soft tissue envelope. The patient underwent resurfacing of his residual limb using a neurotized anterolateral thigh flap with sensory innervation by both the superficial peroneal and saphenous nerves of the residual limb. He recovered uneventfully and was able to achieve consistent prosthetic ambulation. During subsequent orthopedic intervention to address heterotopic ossification, the flap was re-elevated, de-epithelialized, and advanced to optimize the padding of his lateral residual limb.

an area of high cosmetic demand, but often compromised or disregarded in extremity reconstruction.[15] Aesthetic considerations may be applied to the recipient and donor sites alike. Matching tissue quality, color, and contour, while minimizing donor site morbidity, leads to the optimal "like with like" reconstruction. Although some improvements to contour can be made in a secondary manner, in most cases the best results stem from attention to contour at the initial reconstruction.

The donor site should also be considered and may largely be based on patient preference. Primary closure is favored over secondary healing to minimize discomfort or scarring. In some cases, a secondary reconstruction may be considered for the donor site as well.

THE HIERARCHY OF RECONSTRUCTIVE NEEDS IN PRACTICE

The utility of a framework should be judged by its ability to guide clinical decision-making. Figure 3 demonstrates application of the reconstructive hierarchy of needs in two different clinical settings: limb salvage and amputation. The versatility and conceptual appeal of the hierarchy framework is highlighted by its application to clinical scenarios with the seemingly divergent goals of preserving and removing the limb.

After applying the hierarchy of needs to a traumatic wound of the distal third of the lower extremity, a thin fasciocutaneous flap that permits primary donor site closure and has the option for sensate reconstruction is favored to provide critical coverage, facilitate re-entry for bony reconstruction, and contour to the three-dimensional geometry of the lower leg with good cosmesis. An important caveat is that the hierarchy framework favors the quality of the ultimate outcome over the simplicity, brevity or number of surgical procedures required to achieve the outcome. Secondary procedures are often required to achieve optimal aesthetic outcome. The ability for the reconstruction to be refined secondarily is a feature, not a flaw, of the hierarchy framework.

Applied to the amputation setting, the hierarchy framework systematically prioritizes preservation of joints and residual limb bony length, soft tissue envelope durability and relative mobility, thoughtful nerve management to minimize pain and optimize prosthetic function, and limb contour to create an amputation that can most effectively interact with a prosthetic device. Case examples highlighting the application of the hierarchy of needs in clinical practice are included in Figures 4–7.

Although the breadth and quality of techniques and technologies available for reconstruction has grown dramatically, optimal application is hindered by outdated reconstructive frameworks.

A defect-based framework enables reconstructive goals to be clearly defined and appropriately prioritized and can evolve at the pace of our innovative specialty. The hierarchy of needs framework identifies and prioritizes each detail of a reconstructive problem to arrive at a strategy that best meets the functional and aesthetic challenges posed by the reconstructive problem. The optimal reconstruction is thus defined by the defect, not the ability, resources, or effort required of the surgeon. Although institutional limitations and patient factors may prevent realization of higher-order reconstructive goals, they remain a target for achievement whenever possible.

This idea is not new or our own. We have borrowed heavily from the concepts elegantly outlined by the very authors of the reconstructive ladder. In *Reconstructive Surgery: Principles, Anatomy, and Technique*, a text published 15 years after the introduction of the ladder concept, Mathes and Nahai identify the limitations of the ladder paradigm and propose an alternative reconstructive framework, the reconstructive triangle.[16] The triangle was intended to guide selection of surgical options "on the basis of the quality of the anticipated result, regardless of the complexity of the procedure." Unfortunately, the triangle lacked the intuitive appeal that drove widespread adoption of the ladder. However, the triangle served as the spark of inspiration for us to seek comparison to Maslow's triangular hierarchy. Our intent is simply to repackage the sound reconstructive concepts outlined by Mathes, Nahai, and many other reconstructive forebearers into a framework that is as intuitive and accessible as the reconstructive ladder but yields superior clinical outcomes. Both the patient and surgeon are enhanced by a process driven to achieve one's full potential.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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