Soft Tissue Reconstruction Pyramid for the Diabetic Charcot Foot

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KEYWORDS

• Diabetic foot ulcer • Diabetic Charcot foot • Charcot neuroarthropathy
• Soft tissue pyramid • Diabetic neuropathy • Plastic surgery • Reconstruction

KEY POINTS

- Durable soft tissue coverage is essential for the surgical treatment of soft tissue and/or osseous defects in the diabetic Charcot neuroarthropathy (DCN) patient.
- The soft tissue reconstruction pyramid for the DCN patient provides a stepwise approach when managing challenging acute or chronic soft tissue defects.
- Concomitant osteomyelitis in DCN ulcers is optimally addressed with combined osseous and vascularized soft tissue transfer reconstruction.
- External fixation may be used as an adjunctive therapy for surgical off-loading of major soft tissue reconstruction for DCN ulcers.

The incidence of foot ulceration in the diabetic population has been cited as 15%,[1] and in the diabetic Charcot neuroarthropathy (DCN) population, the incidence climbs to 37%.[2] The evidence of the financial burden of diabetic foot ulceration (DFU) treatment[3–11] as well as the negative effect on patient quality of life associated with chronic DFU is staggering.[5,12] In addition, DFU recurrence rates of 25% to 80% have been published, despite enrollment in diabetic shoe programs and regular podiatric visits.[13–16] In addition, the mortality risk of patients with DFU or DCN has been shown to be higher than that for patients with diabetes mellitus alone.[17] The data in this high-risk diabetic population underscore the importance of a durable and reproducible surgical treatment approach to these difficult DCN ulcers when conservative therapy fails.

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Patients with DCN carry the heavy burden of multiple end-organ manifestations of the primary disease. In addition, these patients often have multiple other medical comorbidities, including microvascular and macrovascular peripheral arterial disease, cardiac disease, end-stage renal disease, retinopathy, gastroparesis, and autonomic neuropathy. Preoperative medical optimization of these patients often requires a multidisciplinary team approach and may involve the patient's primary care physician, cardiologist, endocrinologist, nutritionist, nephrologist, infectious disease specialist, and/or vascular surgeon. A thorough history, physical examination, and preoperative laboratory and medical imaging are paramount for the patient's overall successful outcome.

In the presence of DCN and concomitant osteomyelitis or abscess, staged reconstruction is necessary before the final soft tissue coverage and/or osseous reconstruction. Initial multiple surgical debridements, osseous resections, and/or utilization of cemented non-biodegradable antibiotic beads/spacers may be required in order to achieve healthy wound and osseous margins before the definitive surgical reconstruction. Furthermore, basic arterial noninvasive studies are highly recommended in diabetic patients with diminished pulses or signs of peripheral arterial insufficiency. Vascular surgery consultation is warranted in the presence of diminished ankle brachial index, large vessel obstructive disease, or monophasic blunted waveforms to the feet.[18]

The options for soft tissue coverage in the patient with DCN are usually based on anatomic location, size and depth of the ulceration, durability of surrounding soft tissue, the presence or absence of active infection, and underlying deformity. Soft tissue coverage options are often affected by the patient's specific angiology. The reconstructive ladder is a classic tenet of plastic surgery in which tissue coverage techniques are arranged hierarchically from simple to complex. The techniques are applied accordingly based on the soft tissue defect characteristics and were revised recently specifically for patients with diabetes mellitus.[19] In patients with DCN, the ulcerations are more complicated with or without the presence of osteomyelitis and are usually associated with an underlying deformity. As a result, the bottom rungs of the reconstructive soft tissue pyramid[19] (skin equivalents, negative pressure wound therapy, or autogenous skin grafting) are generally used less frequently, owing to the complexities of DCN ulcerations. Ulcer excision with or without exostectomy and/or equinus correction and primary closure of DCN ulcers is the simplest method of soft tissue coverage, but this is often not possible secondary to the size of the wound or the lack of redundant and durable surrounding soft tissue.

SOFT TISSUE COVERAGE OPTIONS FOR THE DIABETIC CHARCOT FOOT

Local Random Flaps

Local random flaps make up the next step in the soft tissue reconstructive pyramid for DCN ulcers (**Fig. 1**). These flaps include the skin, subcutaneous tissue, and sometimes the fascia. The flaps are random in nature without any specific arterial blood supply and may be sometimes based on angiosomes. Bilobed variants[20] and V-Y random advancement flaps may be used for coverage of plantar or malleolar defects, as long as no underlying osteomyelitis is present.[21–24]

Most common local random flaps for soft tissue coverage of DCN ulcerations include the rotational advancement, transpositional, rhomboid, and/or monolobe/bilobed flaps. The use of local rotational advancement flaps based on the medial plantar arterial angiosome is frequently used for plantar-lateral midfoot ulcers in the DCN patient.[25–27] Noninvasive arterial studies are crucial for preoperative planning