

Redefining the Concept of Superconstructs for Management of Lower Extremity Charcot Neuroarthropathy Reconstruction - A Case Series

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Statement of Purpose

We aim to redefine and expand the traditional concept of a “superconstruct” for rearfoot Charcot neuroarthropathy (CN) reconstruction to include a combination of internal and external fixation. The decision to use this construct is based on a patient’s weight, comorbidities and expected compliance. We present a case series of nine patients to illustrate our experience in employing superconstructs for the management of lower extremity CN rearfoot and ankle reconstruction and highlight the circumstances under which this construct should be used.

Literature Review

Traditionally, a superconstruct describes fixation across multiple joints, into healthy bone, for an unstable deformity such as CN (Figs. 1a & b) (1). Bone is resected to allow for deformity correction and decrease tension on the soft tissue envelope. The strongest device allowable by the soft tissues and a device that maximizes mechanical function is recommended (1). This may be a combination of fixation in the form of locking plate and screws, intramedullary beams, staples or external fixation (1-3). This is performed for increased load sharing (4). This type of superconstruct fixation has proven to be more stable than traditional fixation methods across individual joints (1, 4). Many authors have studied various constructs as a means to establish the most stable construct for fixation (2). Although there is a consensus that fixation across multiple joints is more stable, no standard has been set for which construct is best.

The compression strength of different constructs has also been studied. Grant et al. performed a study comparing internal and external fixation constructs as well as a combination of both to see which gave the most compression across an arthrodesis site. The study revealed a combination of internal and external fixation provided a synergistic increase in compression across a fusion site (5). It has also been demonstrated that limb salvage with Charcot reconstruction is successfully achieved with a combination of internal and external fixation (6). There have been no studies looking specifically at fixation for rearfoot CN resulting from the RankL/OPG fracture pathway.



Figures 1a. & b. Rearfoot Charcot with osseous distraction (a) and the traditional “superconstruct” in the midfoot and rearfoot with locking plates and screws spanning multiple joints.

Methodology

Patients who underwent a rearfoot CN reconstruction with internal and external fixation from 2013-2017 were identified. A retrospective chart review was conducted. Patient demographics, comorbidities, procedure details, time in the external fixator, time to fusion and complications were recorded. Successful union, time to union, time in the external fixator and maintenance of correction postoperatively were evaluated.

Procedures & Follow-up

All patients in the study underwent a rearfoot reconstruction with a combination of internal fixation consisting of a tibiototalcalcaneal intramedullary retrograde compression nail and external ring fixation for a non-braceable CN deformity (Figs. 2a & b). All correction was performed acutely. Both the ankle and subtalar joints were prepared for arthrodesis. Bony wedge resection was performed as necessary to allow for deformity correction. The static fixator was applied with a tibial block and foot plate with struts spanning the rearfoot to allow for additional compression across the ankle and subtalar joints (Fig. 2b).

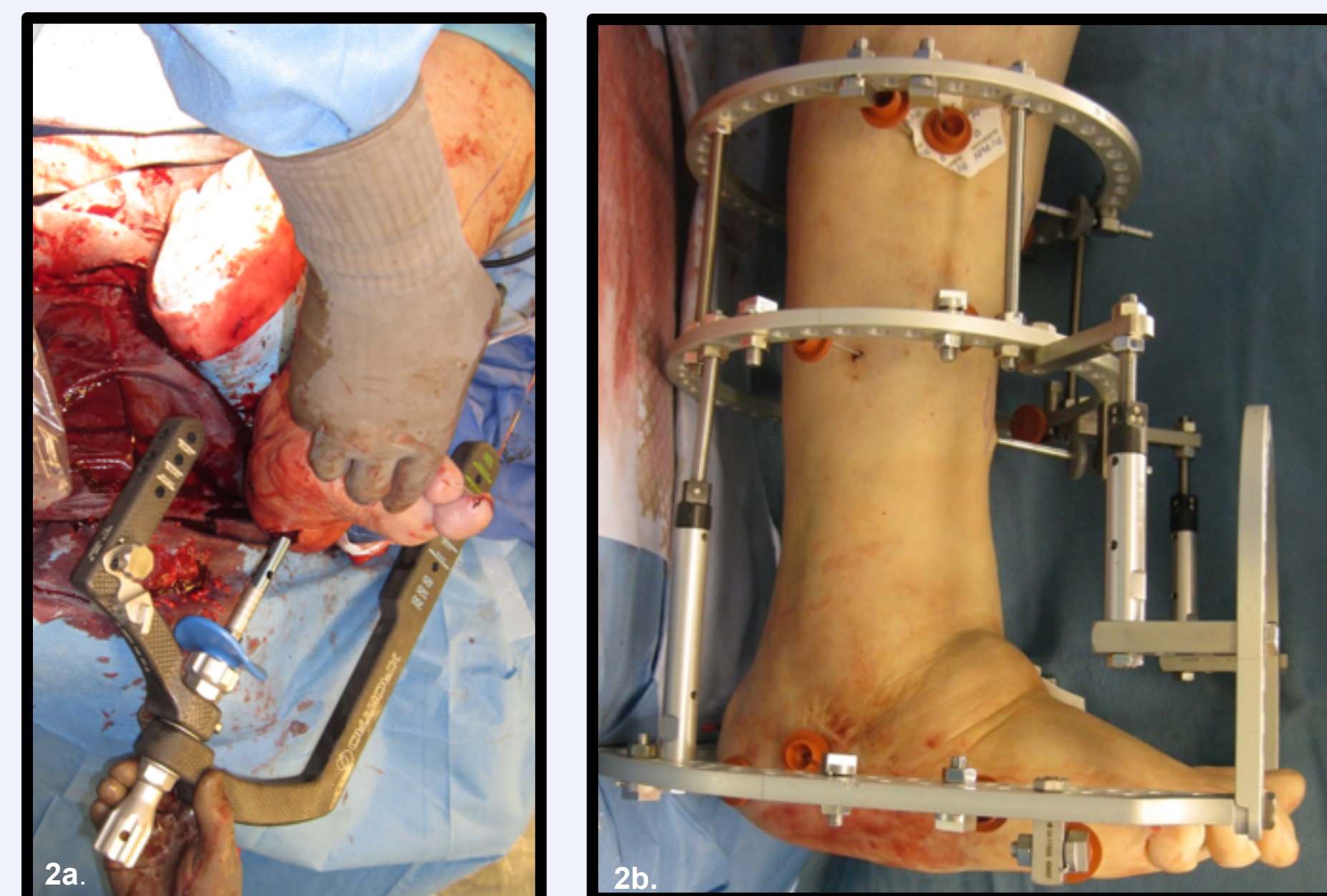


Figure 2a and b. Intraoperative view of insertion of intramedullary compression nail (a) and post internal fixation view with static external fixator (b).

All patients were nonweightbearing for at least 6 weeks. The external fixator was removed between 6 and 12 weeks post index procedure. Some of the patients that underwent intramedullary nail rearfoot fixation were dynamized at a later date if necessary. Arthrodesis was determined clinically and with serial radiographs.

Results

Nine out of ten patients went on to clinical union at an average of 91 days. Minor complications included: superficial infections, wounds, osteomyelitis and fibrous nonunion. Major complications included a below knee amputation in one patient. The average amount of time in the external fixator was 73.3 days. At final follow-up, nine out of ten patients had a rectus foot that was braceable allowing for ambulation. These results are illustrated in Table 1.

Patient	Age	Sex	Contributing Factors	Time in Ex Fix	Time to Fusion	Complications
1	67	M	DM, CKD	67 days	N/A	Non-painful fibrous nonunion
2	67	F	DM, Morbid Obesity	66 days	70 days	Superficial infection
3	52	F	DM, Morbid Obesity, Anemia	90 days	90 days	None
4	57	M	DM, Obesity	67 days	87 days	None
5	56	M	DM, Obesity	140 days	140 days	Wound, osteomyelitis
6	52	M	DM, Alcoholism	48 days	74 days	Superficial infection
7	50	M	DM, Non-compliance	20 days	N/A	BKA
8	68	M	DM, Morbid Obesity	50 days	62 days	None
9	61	F	DM, Anemia, Osteoporosis	112 days	112 days	None

Table 1. Patient demographics, contributing factors, results and complications



Figures 3a and b. Postoperative AP (a) and lateral (b) radiographs showing retrograde intramedullary retrograde nail fixation of a Charcot rearfoot with external ring fixator superconstruct.

Discussion

While we agree with the current definition of a superconstruct, we feel that this should be expanded to include a combination of internal and external fixation especially when treating Charcot rearfoot deformities, which commonly present with the fracture RankL/OPG pathway. It is well known that patients with such pathology have complex factors making management difficult [Table 1]. We recommend this technique for patients who: are obese, have diabetes, exhibit metabolic deficiencies, or who have compliance issues [Table 2].

Furthermore, the addition of external fixation in our novel definition exemplifies the traditional superconstruct definition as being the most stable fixation with minimal soft tissue envelope compromise, while being the strongest and most functional. Upon completion of time in the external fixator, the internal fixation remains. Additionally if complications occur with external fixation (i.e. pin track infections) and early removal is necessitated, internal constructs will remain, essentially as a safe guard for the procedure performed.

This small series demonstrates that combination of internal and external fixation for CN reconstruction in foot and ankle surgery is a viable option. It is beyond the power of this series and current literature to determine the long term viability of this treatment alternative and additional works will be necessary; however, we present nine patients with favorable outcomes at an average final follow-up of 18months.

Recommendations

Recommendations for when to Use Superconstructs

- Uncontrolled diabetes mellitus
- Patients with BMI > 30
- Smokers
- Non-compliant patients
- Patient with metabolic bone deficiencies

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