Continuing Medical Education

Developing a Comprehensive Diagnostic and Treatment Plan for Charcot Neuroarthropathy—Part 2

When conservative therapy is insufficient to manage symptoms, surgery becomes a viable choice.

Objectives

1) The reader should be able to list the indications for reconstruction of a neuroarthropathic deformity.

2) The reader should be able to list the surgical criteria for reconstruction of the neuroarthropathic deformity.

3) The reader should be able to discuss the possible complications of Charcot reconstruction.

4) The reader should be able to discuss the main procedures used to reconstruct Charcot neuroarthropathy.

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*Following this article, an answer sheet and full set of instructions are provided (p. 193).—**Editor***

By Brent Bernstein, DPM and John Motko, RN

Surgical Treatment

In part 1, we discussed the conservative treatment of Charcot foot. In this part, we discuss the surgical management of this debilitating condition. We begin with a review of the literature.

Pinzur reviewed 201 Charcot feet and found that three had primary amputation and five had amputation after failed salvage surgery. Three quarters of the patients had midfoot deformity rather than ankle. 59.2% of the midfoot cases reached desired endpoint without surgery. Of the 40.8% that required surgery, more required osteotomy than simple ostectomy.[76] Myerson, et al., reviewed 116 Charcot midfoot cases and found 7 required amputation. 19 of the patients required arthrodesis while 7 required ostectomy.[77] Saltzman, et al., found that out of 127 Charcot feet treated with only non-operative care, 49% had recurrent ulceration, 23% required long term bracing, and there was a 2.7% annual amputation rate.[78] Many authors have referenced Saltzmans'

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paper from the standpoint of the fallacy of offering only non-surgical care to these patients. In those patients whom conservative has failed to achieve a stable, non-ulcerated, pain-free foot that can be placed in

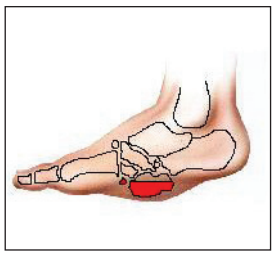

Figure 12: Diagram of Simple Exostectomy

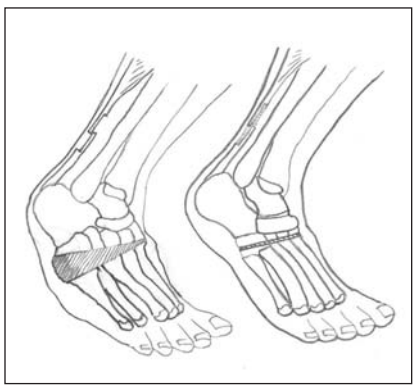

Figure 13: Diagram of Transpedal Osteotomy

footwear—surgery should be offered.

When deciding between surgery and some other stop-gap measure (such as permanent use of a CROW), the surgeon must consider many criteria before proceeding (Table 10). Generally, we prefer to surgerize only after all soft tissue ulcers have healed, edema has resolved and the neuroarthropathy has become inactive to minimize post-operative infections, dehiscence and hardware purchase problems respectively.

Patients with soft tissue or bone infection are taken immediately to first-stage surgery for radical debridement of all devitalized tissue, deep biopsies, placement of antibiotic-loaded cement spacers followed by culture-guided long-term intravenous antibiotics prior to performing corrective surgery and placing hardware. Patients are not taken to the operative theatre for osseous reconstruction until temperatures have equilibrated to the contralateral side, edema is resolved, and ulcerations and infections have healed. While some clinicians have discussed the possibility of arthrodesis in the active phase of Charcot, most agree that the risks of performing reconstructions in

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TABLE 10

Criteria for Charcot Reconstruction

Stable Soft Tissue Envelope
In-Active Neuroarthropathy
Medical Clearance and Optimization
Patient Willingness to Comply with and Tolerate Long Term Off-Loading/Casting/External Fixation
Adequate Vascular Perfusion and Presence of the Plantar Arch
Ability to Non-Weight-bear or Reside in Skilled Nursing Unit x 3 months
Fully Treated Infections of Soft Tissue and Bone
Cessation of Smoking
HbA1C 7
Weight Loss and Conditioning

Figure 14a Case 1: Infrared dermal temperature measurements of acute neuroarthropathy

Figure 14b Case 1: Infrared dermal temperature measurements of contralateral control side unaffected by neuroarthropathy

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the active phase of neuroarthropathy are too great.[79-82]

Researchers have shown that a 25% infection rate exists when patients undergo Charcot reconstructions while ulcerations are open.[83] Typically, patients will be brought to the operative theatre with the total contact cast intact. All patients receive pre-operative doses of prophylactic antibiotics in accordance with good medical practice. Most procedures are performed under general anesthesia due to the length of procedures and the mid-lower leg level of pin placement and Achilles tendon corrections. Occasionally, in patients that cannot tolerate general anesthesia, a spinal block will be performed with tetracaine.

The surgical goals are coverage of deep exposed structures, correction of ankle equinus, restoration of calcaneal inclination and tibia to floor angles, correction of the rearfoot to leg relationship, correction and stabilization of degenerative joint.[84-85] We also require that all patients contemplating surgery undergo smoking cessation due to the overwhelming literature noting bone healing complications related to nicotine.

Another requirement is conditioning, weight loss and gait training with the required assistive devices prior to surgery so that compliance with non-weight-bearing can occur. Patients who take this seriously generally drop the glycosylated hemoglobin levels to a range that we consider the "ticket" to surgery. When patients are required to develop "ownership" of the condition prior to the surgery, we've noted good compliance levels with post-operative restrictions as compared to the general consensus in the Charcot surgeon community.

Lastly, all patients are seen by our internists for clearance and optimization prior to scheduling so that the patient already has a relationship with them prior to being admitted after surgery. We take pride that our patients enter the surgical arena physically and mentally prepared for the surgical procedures and well-educated on the complications that can occur.

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Specific Reconstructive Surgical Procedures

Equinus Correction

Many of our non-surgical patients and all of our surgical reconstructions will have correction of the Achilles tendon contracture. It is the first and most powerful step in correction of these patients. We've noted that our patients undergoing casting have fewer difficulties in the casts when this contracture is cor-

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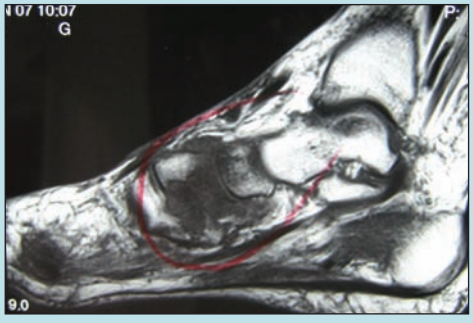

Figure 14c Case 1: MRI of foot confirming acute neuroarthropathy

Figure 14d Case 1: Triple Hemisection of Achilles Tendon Under Local Anesthesia

Figure 14e Case 1: Articulated Ankle Foot Orthosis

Figure 14f Case 1: Healed and Braced

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rected and they cool down into the in-active phase more quickly. Generally, these patients undergo a percutaneous triple hemisection either in our clinic at the time of casting or in our ambulatory procedure unit in the hospital.[86]

In our reconstruction patients, the Achilles must be corrected to allow bony repositioning of the osteotomies and to prevent attenuation of our correction over time due to the strong pull of the triceps. In these patients, we more often perform an open procedure with complete Z-tenotomy and suturing at the corrected physiologic length.

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Occasionally, we encounter frail, non-surgical patients that simply require tenotomy in order to be shoeable and braceable and we accomplish this through a 3 mm. incision over the central aspect of the tendon with a #64 mini-blade followed by cast application with the foot at 90 degrees to the leg. We generally do not perform gastrocnemius recession (open nor endoscopic) due to invariable finding that the contracture is of the conjoined tendons rather than of the gastrocnemius only. This is bolstered by Grant's and others' unique work on tendon glycosylation.[87-90]

Planing

Patients with a simple prominent bony exostosis, usually under the medial column, can forego a full reconstructive osteotomy with fusion. (Figure 12) In those patients, in addition to the mandatory Achilles release, a simple exostectomy is performed to relieve pressure under the prominent bone. These patients do very well generally, and have a low incidence of ulcer recurrence both in our program and in the literature.[91-94] Patients with lateral column ulcers can have local exostectomies, but it has been our experience that they have a higher recurrence rate and have better outcomes when coupled with transpositional flaps.

Rosenblum, et al., had similar results when they performed a retrospective review of lateral column ulcers and performed flaps either as a primary procedure or as a revisional procedure in about half of a 32-patient cohort.[95]

In patients with a varus hindfoot or ankle with lateral foot ulcers, local exostectomy will be rarely met with success and a triple arthrodesis is indicated.[96] In patients with complete collapse into a convex arch with massive forefoot abduction or with severe deformity, so much bone would have to be removed that destabilization of the foot can occur. Planing should not be contemplated in these patients. The procedure of choice would be a midfoot osteotomy.

One important caveat when treating those patients presenting with the "old burnt-out" Charcot foot is to never assume that the initial perfusion that was undoubtedly present during the acute process still exists. In the period of time from onset of Charcot to the presentation in the office—arterial

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Figure 15a Case 2: Pre-Operative Lateral Plain Radiograph Showing Exostosis

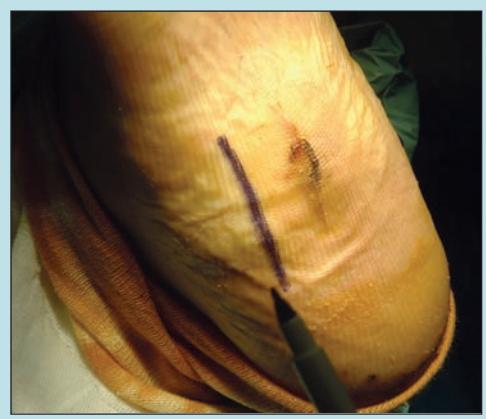

Figure 15b Case 2: Incisional Planning Prior to Exostectomy

Figure 15c Case 2: Surgical Exposure for Exostectomy

stenosis can certainly occur. If the foot is pulseless, if only monophasic flow is audible with a hand-held Doppler, or if lack of retrograde flow of both main arteries is noted—a full noninvasive arterial examination and vascular consultation should be obtained. Treat these patients just as you would the typical patient with a diabetic foot ulcer even when planning the most simple exostectomy or Achilles tendon lengthening.

Midfoot Osteotomy

Most midfoot deformities are characterized by a collapse of the medial and lateral longitudinal arches with a rocker bottom deformity, abduction of the forefoot, and loss of calcaneal pitch due to triceps pull. Many orthopedic and podiatric surgeons perform a biplanar transpedal osteotomy with an achilles tendon lengthening. (Figure 13) The primary differences surround fixation techniques and post-operative restrictions. Osteotomies are described as fixated with standard internal fixation with small screws, plantar plating, static tensioned external framing, bent-wire tensioned external framing, and combination of internal and external fixation.[97-102] Some surgeons initially apply an external frame over the osteotomy and at frame removal apply internal screws to any unstable areas.[113]

One important caveat when treating those patients presenting with the "old burnt-out" Charcot foot is to never assume that the initial perfusion that was undoubtedly present during the acute process still exists.

Our procedure is basically a reverse Cole osteotomy with biplanar wedges to correct both the sagittal plane collapse as well as the forefoot abduction. We utilize K-wire "guide-rails" to mark the bone cuts and perform the cuts with a large power saw. An initial stabilization of the medial and lateral columns is performed with large bore 7.3 mm cannulated screws that act as beams. We take care to make sure that the shank-to-thread junction is not close to the joint fusion site.

Our goal is complete correction of the 1st metatarsal to talus angle in both the coronal and sagittal plane and the beams virtually guarantee this. Once this is accomplished, we apply an external fixator foot ring which is secured to the calcaneous. A forefoot wire is than placed in a bent configuration that is tensioned, causing a dramatic pull back against the calcaneal wire. The bent wire technique coupled with the screw "beams" causes a dramatic synergy of compression across the osteotomy site that has been demonstrated clinically as well in sawbone and cadaver models.[103]

We've abandoned small screws due to the large moment arms present in the midfoot, the roughly million plus load cycles that can occur in a normal patient's year, and the frequency of hardware failure noted in the literature. Our feeling is that with the triceps surgically

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Figure 15d Case 2: Bone Removal with Osteotome

Figure 15e Case 2: Layered Closure Over Drain

Figure 15f Case 2: Post-Operative Lateral Plain Radiograph After Exostectomy

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weakened and with triplane external bracing, a large diameter screw spanning a fibrous nonunion in a Charcot patient will still likely maintain the alignment of the foot. We generally secure our footring to either multiple tibial wires and rings or to a delta configuration with the foot at 90 degrees to the leg.

When we are dealing with an acute, isolated dislocation such as the medial cuneiform, we occasionally forego the external fixation construct and use a plate buttress over a medial column beam.

In the end, our goal in the midtarsus is not just stabilization, but a definitive re-building of the medial and lateral arches with correction of the coronal and sagittal plane deformities. It is important for podiatrists to understand this concept even if Charcot reconstructions are not part of their practice.

When referring a patient for such a reconstruction, any podiatrist should be able to evaluate the post-operative films on their patient. The astute clinician will look past all of the fancy hardware that may be present on plain film and hone in on the radiographic angles present. What should be expected is correction of the first metatarsal to talus angle in both planes both immediately post-surgically and after full-weight-bearing begins post-frame removal. Far too often, temporary framing results in attenuation of the original correction and recurrence of deformity. Full osseous fusion on radiograph is less important than deformity correction and functionality.

Tibiocalcaneal Arthrodesis

Undoubtedly the most challenging neuroarthropathy to correct is the Charcot ankle. In many cases, extreme valgus or varus angulation occur as the tibial mortise drives towards the ground and the foot is pushed out of the way. In addition, the talus will often be pulverized and will virtually dissolve away. While some authors will attempt to salvage portions of the talus, it has been the practice of our program to generally resect all of the non-viable bone and cartilage fragments of talus and perform a distal fibulectomy which allows us to easily reposition the foot on the leg due to the adequate slack that results.

We burr into healthy bleeding bone on both the tibia and calcaneous and perform wedge resections as necessary to place the foot in a plantigrade sagittal plane position and in slight valgus in the frontal plane. At this point, we generally augment the fusion with multiple drillings and placement of recombinant human bone morphogenic protein in a bovine collagen sponge to increase the chances of bony fusion.

We occasionally utilize implantable direct current bone stimulators. Any small deficits are back-filled with ceramic putty, although our aim is healthy raw bone to bone rather than large amounts of fillers, allografts, or autografts. The foot is positioned and temporarily pinned with a large diameter Steinman pin. After fluoroscopy guarantees good positioning, we then apply fixation. We've typically used a retrograde intramedullary nail in the past.[104-107] Although we haven't experienced some of the complications such as loosening, infection, and hardware breakage that have been reported in the literature, we do have questions regarding the true compression obtained.[108-109]

We also prefer to have adjustable fixation that can be re-compressed post-surgically. Due to

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Figure 16a Case 3: Plantar Midfoot Ulceration and Scarring Associated with Rocker-bottom Deformity

Figure 16b Case 3: Surgical Resection of Ulcer, Scar, and Bone with Incisional Planning for Transposition Flap

Figure 16c Case 3: Flap Raised and Inset Into Defect of Midfoot Charcot Deformity

this, we have been phasing into two external fixator options. We either use a large mono-lateral external fixator laterally with Schanz bone screws coated with hydroxyapetite into the tibia proximally and through a T-clamp into the calcaneous distally with a retrograde Steinman pin from calcaneous to tibia to prevent shifting or angulation or a standard multi-ring external cage. We then apply compression to the osteotomy. Both can be augmented with percutaneous screws. We've had good success with both techniques.

Other Procedures

Less frequently, our patients will require more exotic procedures such as supramalleolar osteotomies of the tibia, open reduction and fixation of calcaneal insufficiency fractures (Type V Sanders) and Symes amputations in non-reconstructible feet.

Our Experience

A retrospective analysis of our primary authors' patient population reveals that we've treated a total of 140 patients with neuroarthropathy since 2005. 17% of these patients suffered from bilateral disease. The female to male ratio was 54 to 86. The underlying neuropathy causing the Charcot joints in our population was caused by alcohol consumption in 4 patients. Cord compression, syphylis, hemachromatosis and gouty neuropathy each contributed 1 patient. The remaining 103 patients had varying types of diabetes mellitus. 18 underwent a simple percutaneous Achilles tendon lengthening, while 43 underwent an operative procedure of some type (arthrodesis, bone resection, etc.). Therefore, 57% of our patient population were managed without surgical intervention of any sort. The majority of our patients were referred by other podiatrists, vascular surgeons, plastic surgeons, pedorthists, and primary care physicians.

Undoubtedly the most challenging neuroarthropathy to correct is the Charcot ankle.

Case Studies

Case 1

This diabetic neuropath female in her sixties presented with an warm, swollen, tender Right foot and was diagnosed with active phase neuroarthropathy based on her history, clinical examination, infrared temperatures, radiographs, and serologic bone markers. (Figures 14a-c) A significant equinus deformity was noted but the foot was plantigrade and not ulcerated. She began a course of oral bisphosphonate therapy as well as total contact casting and also had a percutaneous triple hemisection of her Achilles tendon. (Figure 14d) The patient progressed from the active to in-active phase without collapse and was transitioned to an articulated, molded foot ankle orthosis. (Figure 14e-f)

Case 2

This middle-aged male with history of peripheral neuropathy secondary to hemachromatosis presented with a Right in-active Charcot midfoot deformity and a history of chronic and recurrent foot ulcers despite shoe and insert modifications. (Figure 15a) The patient underwent local exostectomy and when healed was shod in custom inserts in depth shoes without recurrence. (Figures 15a-f)

Case 3

This male diabetic neuropath in his seventies presents with chronic and recurrent Left plantar lateral midfoot ulcer under a collapsed, in-active Charcot deformity (Figure 17a). An equinus deformity was present. The patient had suffered a contralateral below-knee amputation. Although we healed the wound through off-loading, the area was chronically scarred

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Figure 16d Case 3: Healed Flap with Resolved Ulceration, Scar and Deformity

Figure 16e Case 3: Double Upright Brace and Shoe Combination Utilized When Completely Healed

and unstable with an underlying exostosis. The patient underwent a local exostectomy with excision of the scarred area. A transposition flap was inset to cover the deficit and a split thickness skin graft was harvested from the ipsilateral calf and used for donor site coverage. (Figure 17b-d) The patient progressed uneventfully to healing and was finally transitioned to footgear with custom insoles and a double upright calf brace (Figure 17e).

TABLE 11

Surgical Complications of Charcot Surgery

- Dehiscence
- Deep infection
- Dissecting hematoma
- Significant Blood Loss and Need for Transfusion
- Superficial infection/Pin Tract Infection
- Hardware Failure
- Pain
- Edema
- Stress Fractures of Tibia
- Nonunion/Fibrous Anklyosis
- Recurrence of Deformity
- Re-Activation of Acute Neuroarthropathy in Ipsilateral Extremity
- New Onset Neuroarthropathy in Contralateral Extremity

Case 4

This middle-aged diabetic female presented with an insensate, warm, swollen, erythematous Right foot. She had a history of developing osteomyelitis of her 2nd toe on the same foot and had underwent an elective toe amputation which healed uneventfully (Figures 18a-b).Within one month, however, she developed inflammatory signs and sought multiple opinions until finally referred to the author. She was diagnosed with active Charcot neuroarthropathy based on the history of recent trauma (surgery), neuropathy, asymmetric infrared cutaneous temperature readings, flail first ray, and positive radiographs for sudden arthrosis and dislocation of the first metatarsocuneiform joint (Figures 18c-e).

The patient underwent immediate off-loading with knee scooter, compression wraps, ice therapy, and elevation. When edema had re-

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Figure 17a Case 4: Neuropathic Patient with Osteomyelitis of Second Toe Stump

Figure 17b Case 4: First Metatarsal Base of Patient Prior to Second Toe Amputation

Figure 17c Case 4: Plain Radiograph Post-Amputation of Second Toe

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solved, she proceeded with surgical fusion of the first metatarsocuneiform joint with plate and beaming with correction of the dorsiflexed first ray (Figures 18f-g). She continued non-weight-bearing with scooter; finally transitioning through total contact casts to depth shoes and insoles.

57% of our patient population were managed without surgical intervention of any sort.

Complications

"Surgerizing" these patients is not to be undertaken lightly. Rogers, et al., discussed the complication rate of Charcot reconstructions with external fixators. He found that 56% of the patients suffered wound dehiscence, 25% suffered pin failure, and 31% had pin tract infections. The risk factors associated most strongly with post-operative complications in his paper were younger age, long tourniquet time, and pre-operative hyperglycemia. Thordarson, et al., identified the additional risk factors for non-union, including psychiatric disorders, illicit drug use, alcohol, nicotine abuse, and open fractures along with diabetes as risk factors when discussing ankle fusions. Complications and alternatives such as elective amputation, palliative wound and Charcot care (such as the CROW boot) are discussed clearly with our patients when obtaining surgical consent. (Table 11)

Conclusion

Charcot neuroarthropathy is a complicated disease process to diagnosis, classify, and treat successfully. Clinicians must review the literature and avoid dogma. A comprehensive diagnostic and treatment program combing the best ideas and research across multiple specialties, including our own unique additions, has been presented. Through diligent care and referral patterns, the clinician can tilt the balance in favor of a good outcome when encountering this devastating complication. ■

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Figure 17d Case 4: Plain Radiograph of First Metatarsal Base After Toe Amputation in Same Foot

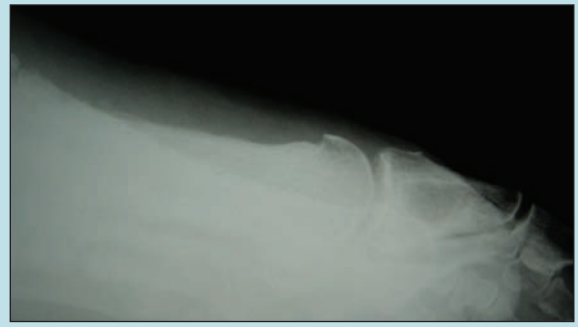

Figure 17e Case 4: Plain Radiograph Showing First Metatarsal Elevatus

Figure 17f Case 4: Post-Reconstruction Lateral Plain Film Showing Internal Beaming and Buttress Plate

Figure 17g Case 4: Post-Reconstruction Dorso-Plantar Film Showing Internal Fixation and Stabilization of Medial Column

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Dr. Bernstein is board certified by the American Board of Podiatric Surgery and is a Fellow of the American College of Foot and Ankle Surgeons. He graduated from Temple University School of Podiatric Medicine and completed both a residency in foot surgery and a fellowship in limb salvage surgery with Dr. Stanley Kalish in Atlanta, Georgia. He currently practices in the Lehigh Valley and is program director of the Charcot and Reconstructive Foot Program at St. Luke's Hospital and Health Network, Quakertown Campus. Dr. Bernstein participates in mission trips to impoverished regions to perform pediatric deformity surgery on a yearly basis.

John Motko is a registered nurse who works at the Wound Management Center St. Luke's Health Network, Quakertown Campus. He has a BS in Nursing from Moravian College/ St. Luke's School of Nursing. He is certified in wound care from both the American Academy of Wound Management and the Wound, Ostomy and Continence Nurses Society. He is also a Certified Hyperbaric Registered Nurse. He has over seven years of clinical experience in caring for patients with chronic non-healing wounds and Charcot neuroarthropathy.

EXAMINATION

Continuing Medical Education

See answer sheet on page 193.

1) Criteria necessary to consider a Charcot foot reconstruction include:
- A) A healed soft tissue envelope
- B) successful pancreatic transplant
- C) patient age under 45 years old
- D) active, inflammatory stage of neuroarthropathy

2) The preferred option in treatment of Charcot deformities with concomitant bone infection includes:
- A) primary amputation of the affected foot
- B) two-stage procedure with resolution of infection followed by reconstruction
- C) one-stage osteomyelitis resection and reconstruction
- D) conservative treatment only

3) Surgical procedures that are indicated in a severe rocker-bottom deformity are:
- A) Tibiocalcaneal arthrodesis
- B) Transpedal wedge osteotomy
- C) Achilles tendon lengthening
- D) B+C

4) The appropriate surgical procedure for a Charcot foot with a fixed varus hindfoot and history of lateral column ulcerations is:
- A) Exostectomy
- B) Syme's amputation
- C) Triple arthrodesis
- D) Tibiocalcaneal arthrodesis

5) Indications for surgery for Charcot foot:
- A) Uncontrolled pain
- B) Unresponsive ulceration
- C) Unshoeable deformity
- D) Any of the above

6) Optimization of reconstructive outcomes in neuroarthropathy includes:
- A) Pre-operative weight loss and conditioning
- B) Peri-operative smoking cessation
- C) Ability to tolerate off-loading and fixation apparatus
- D) All of the above

7) Virtually all Charcot reconstructions will include the following procedures:
- A) Intramedullary nail fixation
- B) Triceps surae lengthening
- C) Invasive bone growth stimulators
- D) A+C

8) Charcot neuroarthropathy of the ankle with severe valgus or varus deformity is best treated surgically with:
- A) Tibiocalcaneal or Tibiotalocalcaneal fusion
- B) Midfoot osteotomy
- C) Triple arthrodesis
- D) B+C

9) Stage II Charcot neuroarthopathy of the midfoot with a severe rocker-bottom deformity and equinus is best treated surgically with:
- A) Tibiocalcaneal fusion
- B) Achilles tendon lengthening and percutaneous pinning of the midfoot joints
- C) Achilles tendon lengthening and Midfoot osteotomy
- D) Achilles tendon lengthening and tibiocalcaneal fusion

10) Patients undergoing neuroarthropathy reconstructions while suffering from an open ulceration:
- A) Have a higher post-operative infection rate
- B) Have a lower post-operative infection rate
- C) Have more pain post-operatively
- D) Have less pain post-operatively

11) Complications associated with external fixators in Charcot reconstructions include:
- A) Pin tract infections
- B) Pin failure/fracture
- C) Dehiscence
- D) All of the above

12) Options that should be discussed with each patient contemplating a Charcot reconstruction are:
- A) Elective amputation
- B) Palliative care
- C) Reconstruction
- D) All of the above

13) A patient suffering from recurrent ulcerations under a subluxed medial cuneiform without a rockerbottom deformity. The ulcers recur despite shoegear and bracing modifications. The patient should be offered:
- A) Midfoot osteotomy
- B) Local exostectomy
- C) Tibiocalcaneal fusion
- D) An isolated achilles tendon lengthening with bone removal

14) Recent research has shown that patients with neuroarthropathy treated without surgery have an ulcer recurrence rate of roughly:
- A) 0%
- B) 50%
- C) 100%
- D) No one has performed this research

15) The following can be utilized to enhance bone healing in surgical fusions of Charcot patients:
- A) bone growth stimulators
- B) Pridie's perforations
- C) bone morphogenic protein
- D) all of the above

Continued on page 192

Continuing Medical Education

EXAMINATION

(cont'd)

16) Complications that should be discussed with patients prior to considering reconstruction include:
- A) Acute neuroarthropathy
- B) Worsening of lower extremity peripheral neuropathy
- C) Infection
- D) A+C

17) Recent research has shown that optimal compression of an arthrodesis occurs with the use of:
- A) K-wires
- B) Screws
- C) External fixator over screws
- D) Jones compression dressing

18) A patient presenting with Stage I neuroarthropathy of the midfoot, rocker-bottom deformity, obesity, nicotine use and an open ulceration should be:
- A) Enrolled in smoking cessation, diabetes education, and exercise classes
- B) Treated with total contact casting until resolution of ulceration and temperatures
- C) Scheduled for surgery
- D) A+B

19) A patient presenting with Stage 0 neuroarthropathy of the midfoot without significant deformity (non-smoker, physically fit and without ulceration) should be:
- A) Enrolled in smoking cessation, diabetes education, and exercise classes
- B) Treated with total contact casting until equilibration of temperatures
- C) Scheduled for surgery
- D) A+B

20) A patient (non-smoker, physically fit and without ulceration) presenting with Stage 2 neuroarthropathy of the ankle with severe valgus deformity, and limited activities of daily living due to inability to wear brace or shoe should be:
- A) Told that an amputation is the only option
- B) Considered for surgical reconstruction of the neuropathic ankle
- C) Prescribed a wheelchair
- D) Considered for surgical planing of the prominent bones on the bottom of the foot

See answer sheet on page 193.

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Developing a Comprehensive Diagnostic and Treatment Plan for Charcot Neuroarthropathy—Part 2 (Bernstein and Motko)

Circle:

1.	A	B	C	D	11.	A	B	C	D
2.	A	B	C	D	12.	A	B	C	D
3.	A	B	C	D	13.	A	B	C	D
4.	A	B	C	D	14.	A	B	C	D
5.	A	B	C	D	15.	A	B	C	D
6.	A	B	C	D	16.	A	B	C	D
7.	A	B	C	D	17.	A	B	C	D
8.	A	B	C	D	18.	A	B	C	D
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10.	A	B	C	D	20.	A	B	C	D

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