



Charcot neuroarthropathy of the foot: diagnosis, offloading and reconstruction

Neuroartropatía de Charcot del pie: diagnóstico, descarga y reconstrucción

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ABSTRACT

Charcot neuroarthropathy is a noninfective, progressive destruction of the bones and joints of a neuropathic foot that, when unrecognized, leads to deformity, ulceration, infection and amputation. This narrative review synthesizes the evidence published up to 2024 on the diagnosis, offloading and reconstruction of Charcot neuroarthropathy of the foot, organized by three thematic axes and their chronological trajectory. The synthesis indicates that diagnosis has shifted from radiographic staging toward earlier recognition with magnetic resonance imaging, although no single test reliably separates active Charcot from osteomyelitis. Offloading remains the cornerstone of management, with the total contact cast as reference standard, and earlier offloading in stage 0 shortens treatment and reduces recurrence. Reconstruction, reserved for deformity, instability and failed offloading, has evolved from exostectomy toward axial beaming and intramedullary nailing, but complication rates remain high. The evidence base is dominated by retrospective series and small trials, and comparative studies between techniques are scarce.

Keywords: Charcot neuroarthropathy; diabetic foot; foot deformities; offloading; arthrodesis; diagnostic imaging.

RESUMEN

La neuroartropatía de Charcot es una destrucción progresiva no infecciosa de los huesos y las articulaciones de un pie neuropático que, cuando no se reconoce, conduce a deformidad, ulceración, infección y amputación. Esta revisión narrativa sintetiza la evidencia publicada hasta 2024 sobre el diagnóstico, la descarga y la reconstrucción de la neuroartropatía de Charcot del pie, organizada en tres ejes temáticos y su trayectoria cronológica. La síntesis indica que el diagnóstico se ha desplazado desde la estadificación radiográfica hacia el reconocimiento temprano con resonancia magnética, aunque ninguna prueba aislada separa de forma fiable el Charcot activo de la osteomielitis. La descarga sigue siendo el pilar del tratamiento, con el yeso de contacto total como referencia, y la descarga temprana en estadio 0 acorta el tratamiento y reduce la recidiva. La reconstrucción, reservada para deformidad, inestabilidad y fracaso de la descarga, ha evolucionado desde la exostectomía hacia la fijación axial y el enclavado intramedular, pero las tasas de complicaciones siguen siendo altas. La evidencia está dominada por series retrospectivas y ensayos pequeños, y los estudios comparativos entre técnicas son escasos.

Palabras clave: neuroartropatía de Charcot; pie diabético; deformidades del pie; descarga de peso; artrodesis; diagnóstico por imagen.

INTRODUCTION

Charcot neuroarthropathy of the foot is a noninfective, progressive destruction of the bones and joints that develops in a neuropathic and insensate foot, most often in a person with long-standing diabetes and peripheral neuropathy. Jean-Martin Charcot described neuropathic arthropathy in patients with *tabes dorsalis* in 1868, and the diabetic form of the disease was recognized in the first half of the twentieth century.(1)The clinical sequence is well documented: a warm, swollen and erythematous foot appears without an obvious portal of entry, and if the process is not interrupted it advances to fracture, dislocation and collapse of the midfoot or ankle, a plantar prominence, ulceration, deep infection and, in a substantial proportion of patients, lower-limb amputation.(2,3)

The burden of the disease extends beyond the foot itself. Reported prevalence among people with diabetes varies across settings, and the condition concentrates in those with the longest duration of diabetes and the most advanced neuropathy, a distribution that explains why it surfaces most in services caring for established rather than newly diagnosed diabetes.(2,4) In a population cohort of veterans in the United States, the mortality risk of Charcot arthropathy was higher than that of diabetic foot ulcer or diabetes alone,(5)and mortality after an acute Charcot foot remained elevated in a prospective series from the Netherlands.(6)More recent observational work has identified incident Charcot as a predictor of amputation, with peripheral arterial disease and infection among the factors that drive limb loss,(7)and a systematic synthesis of risk factors has linked the condition to neuropathy duration, obesity and other markers of advanced diabetes.(8)Charcot neuroarthropathy is therefore a limb-threatening and life-shortening complication, not an isolated radiographic curiosity.

The pathophysiology explains why the condition advances silently. Loss of protective sensation permits repetitive trauma to an unprotected foot, and the acute phase is driven by a receptor activator of nuclear factor kappa-B ligand dependent burst of osteoclastic activity that resorbs bone before the radiograph declares the injury.(9,10) The classical descriptions divided the natural history into an active inflammatory stage and a later reparative stage, a distinction that still organizes treatment decisions.(4)Because the process is painless, patients present late, and the earliest opportunity to intervene is lost before the diagnosis is even considered.

Evidence on how to recognize, offload and reconstruct the Charcot foot has accumulated in a fragmented way across podiatry, orthopaedic surgery, endocrinology and radiology journals. A dedicated international guideline on active Charcot neuro-osteoarthropathy was published in 2024 within the International Working Group on the Diabetic Foot framework,(11)and its supporting systematic review brought together the available diagnostic and treatment studies.(12)Between 2015 and 2024 the field moved in three directions that justify a new synthesis: earlier diagnosis based on magnetic resonance imaging rather than on established radiographic destruction, a reappraisal of offloading intensity and duration, and a wider adoption of internal and external fixation strategies for reconstruction.

The aim of this narrative review is to synthesize the evidence on the diagnosis, offloading and reconstruction of Charcot neuroarthropathy of the foot published up to 2024, organized by three thematic axes and their chronological trajectory. A narrative rather than systematic design was chosen because the literature is heterogeneous in design and setting and because the questions of interest concern how practice evolved, which a chronological synthesis captures more directly than a pooled estimate. The review does not claim systematic coverage; it maps where the literature converges, where it diverges and where the evidence remains thin.

DEVELOPMENT

Diagnosis: from radiographic staging to early magnetic resonance imaging

The reference classification of Charcot neuroarthropathy has remained, since 1966, the radiographic staging of Eichenholtz, which describes a destructive phase, a coalescent phase and a reconstructive phase, supplemented by the anatomical classification of the affected region of the foot and ankle.(13) The strength of the system is its wide adoption and its correspondence with the radiographic appearance that clinicians recognize; its weakness is that it anchors the diagnosis to established bone destruction, at a point when structural deformity has already begun. The clinical literature converges on a warm, swollen, insensate foot as the defining presentation and on the observation that waiting for the characteristic radiograph delays treatment, because plain radiographs underrepresent the early, inflammatory phase of the disease.(14,15) The persistence

of this problem is documented in a systematic review of delayed diagnosis, which found that missed or late recognition of Charcot neuroarthropathy remains common and is associated with worse outcomes.⁽¹⁵⁾ A parallel review of the differential diagnosis reached the same conclusion and emphasized the breadth of conditions that must be excluded before the diagnosis of Charcot is accepted.⁽¹⁶⁾

From 2015 onward, the diagnostic emphasis shifted toward detecting the active process before radiographic destruction. Magnetic resonance imaging visualizes bone marrow edema, soft tissue inflammation and microfractures that plain radiographs do not show, and it has become the principal modality for early recognition.^(17,18) A randomized feasibility study of serial magnetic resonance imaging conducted in a specialist foot clinic showed that imaging-guided decisions could shorten total contact cast treatment, supporting the principle that earlier and more objective monitoring changes care.⁽¹⁹⁾ A seven-year retrospective analysis reported that early diagnosis with magnetic resonance imaging was associated with shorter offloading and fewer structural complications.⁽¹⁷⁾ The differential diagnosis with osteomyelitis remains the central difficulty: both conditions present with a warm, red, swollen foot in a patient with diabetes, and the distinction determines whether antibiotics and debridement are needed. Dual-modality techniques such as labelled leukocyte scintigraphy combined with single photon emission computed tomography have been proposed to separate infection from neuroarthropathy,⁽²⁰⁾ and nuclear medicine guidance places hybrid imaging among the recommended tools for this question.⁽¹⁸⁾ Bone scintigraphy with single photon emission computed tomography has also been explored for the characterization and early detection of stage 0 disease.⁽²¹⁾

The arc of imaging between 2015 and 2024 is one of increasing sensitivity at increasing cost. Plain radiographs remain the first examination because they are available everywhere and establish the Eichenholtz stage, but they are insensitive to the active process.⁽¹³⁾ Magnetic resonance imaging added the ability to see marrow edema and soft tissue inflammation, and nuclear techniques added the ability to label infection, each step improving discrimination while narrowing the settings in which the examination is feasible.⁽¹⁸⁾ The imaging guidance published for the diabetic foot codifies this division of labor, assigning each modality to the question it answers best.⁽¹⁸⁾

Skin temperature has served as the traditional bedside surrogate for disease activity, and the stage 0 construct, a hot and swollen foot without radiographic change, depends on it.⁽²²⁾ The evidence for temperature-guided decisions is nonetheless thin, and the feasibility trials that used serial magnetic resonance imaging to shorten cast treatment illustrate an unresolved tension between a cheap and accessible measure and a more accurate but less accessible one.^(14,19) The diagnostic literature therefore leaves the clinician with a layered rather than a hierarchical approach: clinical recognition first, magnetic resonance imaging to confirm activity, and hybrid nuclear techniques reserved for the specific question of infection.^(18,20)

Beyond imaging, biological markers of bone turnover and inflammation have been investigated as adjuncts to diagnosis and activity monitoring. A prospective study of candidate serum and tissue biomarkers in people with type 2 diabetes found suggestive differences between active Charcot and control feet, but no marker has reached the diagnostic performance required for routine use.⁽²³⁾ Classification proposals have multiplied since the Eichenholtz stages were introduced, and a review of the evolution of classification systems concluded that none has resolved the tension between early biological activity and late radiographic structure.⁽¹³⁾ The practical consequence is that diagnosis remains clinical and probabilistic, and this is the position adopted by the 2024 international guideline, which couples clinical recognition of the warm insensate foot with early imaging and explicit attention to the alternative diagnosis of infection.⁽¹¹⁾ Barriers to implementing even this pragmatic approach are documented: surveys of practitioners and audits of acute Charcot care describe inconsistent assessment, delayed referral and uneven access to magnetic resonance imaging, which together account for much of the avoidable delay.^(14,24)

The 2024 international guideline consolidates these threads into a practical algorithm. It advises clinicians to suspect active Charcot in any warm, swollen foot with neuropathy and no other explanation, to confirm activity with imaging, to exclude osteomyelitis when infection is plausible, and to offload without waiting for the radiograph to change.⁽¹¹⁾ The commentary that followed the guideline in the wound care literature repeats the same message, that the diagnosis is a bedside judgement supported rather than replaced by imaging.⁽¹²⁾ This convergence between guideline and commentary is notable in a field whose historical teaching had instructed clinicians to wait for radiographic confirmation.⁽¹⁵⁾

Offloading: from plaster casting to monitored remission

Offloading is the cornerstone of treatment for active Charcot neuroarthropathy because mechanical stress is the driver of the destructive cycle. The total contact cast remains the reference standard for the active phase and the first recommendation of the 2024 international guideline, which specifies a non-removable, well-moulded cast changed at intervals until the inflammatory phase resolves.⁽¹¹⁾ The supporting systematic review for that guideline found that the evidence base for any single offloading modality is limited, with few comparative studies, which explains why practice continues to vary between centers.⁽¹²⁾ A systematic review published in 2024 addressed the question of whether weight bearing within a total contact cast is safe and found that the available studies are small and inconsistent, so the traditional recommendation of non-weight bearing persists despite weak direct evidence.⁽²⁵⁾

The two systematic reviews available for offloading diverge on weight bearing because they ask different questions of the same thin literature. The guideline review concluded that no modality is supported by strong evidence,⁽¹²⁾ while the focused review of weight bearing within the total contact cast could not rule out either strategy.⁽²⁵⁾ This divergence is a consequence of design rather than disagreement about the data: the underlying studies are small, mostly retrospective, and measure different outcomes over different periods, so both reviews report uncertainty and the clinician is left without a decisive answer.

The timing of offloading matters more than the specific device in the recent literature. A registry-based study from Sweden reported that offloading initiated in stage 0 was associated with a shorter total contact cast treatment and a lower risk of recurrence than offloading begun in later stages.⁽²⁶⁾ A cohort study reached a compatible conclusion, showing that early treatment of stage 0 and stage I disease could avoid major amputations at one year,⁽²⁷⁾ and an earlier descriptive series of stage 0 Charcot documented the clinical features and offloading modalities used in that window.⁽²²⁾ These findings, all retrospective, support the intuitive principle that interrupting the inflammatory phase before structural collapse improves the trajectory, but they are vulnerable to confounding by indication because patients detected earlier may differ systematically from those detected late.

Alternatives to the total contact cast have been developed to improve tolerability and access to wound care. Ventral windowed total contact casts allow inspection and local treatment of the foot while preserving offloading,⁽²⁸⁾ and protected full weight bearing in a purpose-built orthopedic device achieved remission in a prospective cohort, challenging the assumption that absolute non-weight bearing is always required.⁽²⁹⁾ Achilles tendon lengthening combined with a weight-bearing total contact cast has been reported for early midfoot Charcot with acceptable deformity control.⁽³⁰⁾ The choice among these devices is governed less by comparative evidence than by ulcer status, patient adherence and the resources of the treating service, a point emphasized in the offloading guideline of the International Working Group on the Diabetic Foot.⁽³¹⁾

Determining when the acute phase has ended, and therefore when offloading can stop, remains underdeveloped. A systematic review of techniques to monitor remission found that skin temperature and radiographic appearance are the most used surrogates but that few have been validated.⁽³²⁾ The Balgrist score, a structured clinical and radiographic instrument, was proposed to predict the duration of offloading treatment and offers one attempt to make the end of treatment objective.⁽³³⁾ Once remission is achieved and footwear is resumed, the risk does not disappear: plantar pressure and footwear adherence predict ulcer recurrence in people with a residual Charcot midfoot deformity,⁽³⁴⁾ and surgical offloading has been explored as a strategy to achieve durable ulcer remission in selected patients.⁽³⁵⁾ Audit data from a regional service show that people with acute Charcot are assessed and managed unevenly, which reinforces the case for structured pathways that standardize the timing and intensity of offloading across settings.⁽²⁴⁾

Among the removable options, the removable cast walker and its Charcot-specific variants occupy the middle ground between the total contact cast and ordinary footwear, and they are included in the offloading guideline as alternatives when the total contact cast is unavailable or contraindicated.⁽³¹⁾ The principle that unites all devices is mechanical: the load must be distributed across the whole plantar surface and the ankle constrained, and the windowed and device-based series confirm that this principle can be met without a traditional cast.^(28,29)

Adherence conditions the success of any offloading device, and the removable alternatives trade protection for acceptability. Studies of footwear after Charcot midfoot deformity show that plantar pressure returns once the patient resumes unsupported weight bearing, and that recurrent ulceration tracks adherence and pressure rather than the device chosen.⁽³⁴⁾ This line of evidence cautions against attributing outcome differences to the cast itself when the behavior that the cast

enforces is the true mechanism, a distinction that the guideline authors also make when they rank devices by the degree of mechanical protection delivered.(12,31)

Pharmacologic modulation of the osteoclastic phase has been tested but has not entered standard treatment. A phase II trial of denosumab reported reduced inflammation and favorable changes in bone metabolism in active Charcot,(36) and observational work on anti-inflammatory and antiresorptive therapy found improved long-term foot outcomes.(37) The pharmacologic literature, reviewed from a bone metabolism perspective, is mechanistically coherent, with the receptor activator of nuclear factor kappa-B and its ligand as the target, but it remains proof of concept rather than established therapy.(10,38) Between 2015 and 2024, offloading therefore consolidated around earlier intervention and monitored remission, while the comparative evidence that would settle device and duration questions remained sparse.

Reconstruction: from exostectomy to axial beaming and intramedullary nailing

Surgical reconstruction is reserved for the foot that cannot be managed by offloading alone: recurrent ulceration over a bony prominence, instability, a non-plantigrade deformity that precludes footwear, or infection that requires resection. The indications have been stable for two decades and are restated in current reviews of surgical outcomes(39) and in the arthrodesis literature.(40) Exostectomy, the removal of a plantar prominence, remains the least invasive option for a stable, shoeable foot with a rocker-bottom ulcer, and minimally invasive exostectomy has been reported as an option with lower soft tissue morbidity.(39) The trajectory of the field, however, moved toward stabilizing the skeleton itself, because deformity recurrence after simple resection is common when instability persists.(40)

For midfoot collapse, the dominant developments between 2015 and 2024 were axial beaming and extended fixation. Beaming, in which intramedullary screws or bolts are placed along the medial and lateral columns, aims to restore a plantigrade, load-bearing foot and has become a widely described technique.(41) Superconstruct plating, which fixes the segment beyond the zone of injury to a stable host bone, is the internal alternative, and a review of midfoot fusion with superconstructs reported high union rates alongside the expected complications.(42) A systematic review of surgical fixation for midfoot Charcot found union in the majority of operated feet but wide variation in techniques and outcomes across studies.(43) External fixation, including hexapod circular frames, is reserved for instability, infection, soft tissue compromise and multiplanar deformity, and is described in dedicated technique reviews.(44) A comparative study of minimally invasive and open approaches to midfoot reconstruction found broadly similar union and complication profiles, suggesting that the surgical approach matters less than the stability achieved.(45)

For the ankle and hindfoot, tibiotalar calcaneal arthrodesis with a retrograde intramedullary nail is the principal strategy, and functional outcomes after hindfoot nailing improve, with quality of life gains reported in follow-up studies.(46,47) Earlier series had already established retrograde nailing as feasible for Charcot ankle arthropathy.(48) The surgical management of chronic Charcot neuroarthropathy, in which deformity is established and infection is common, is addressed separately in the literature because the goals differ from those of the acute foot: resection of infected bone, soft tissue coverage and durable limb salvage take precedence over anatomical restoration.(49) Osteomyelitis complicates the decision and is reviewed as a distinct problem in the surgical literature, where limb salvage competes with primary amputation.(50)

The choice between internal and external fixation is governed by the soft tissue envelope and the presence of infection rather than by any demonstrated superiority of one method. Hexapod circular frames allow gradual, multi-planar correction and are favored when the skin is compromised, whereas internal beaming and plating require a clean, closed wound and offer earlier weight bearing.(41,44) No randomized comparison exists, and the systematic reviews that aggregate fixation outcomes report union and complication figures that overlap widely, which prevents any ranking of techniques.(43) The patient perspective appears only sporadically in this literature: quality of life improved after tibiotalar calcaneal arthrodesis in the available cohort studies, and the same studies caution that the gains are measured against a baseline of severe disability and high mortality.(47,51)

The sequencing of reconstruction also changed between 2015 and 2024. Where infection is present, the literature favors staged treatment in which debridement and provisional stabilization precede definitive arthrodesis, and circular external fixation is the frame of choice for the infected or soft-tissue-compromised foot.(44,50) This staged philosophy reflects the recognition that the complications of single-stage reconstruction in infected bone, nonunion and deep sepsis, are the principal drivers of amputation.(52,53) The shift toward staged surgery and external fixation is thus a response to the complication data rather than a preference for a particular implant.

The complication burden of reconstruction is the reason the indication is kept narrow. A series from a German center reported a high rate of complications after corrective midfoot and subtalar arthrodesis with Achilles tendon lengthening, including nonunion, hardware failure and infection.(52)Amputation after midfoot reconstruction remains a measurable outcome, and a study of minor and major amputation rates following reconstructive surgery quantified the residual limb-loss risk.(53)Long-term mortality after Charcot reconstruction is substantial and tracks the advanced diabetes and comorbidity of the operated population,(51)while a meta-analysis of amputation and mortality in Charcot foot arthropathy placed these risks in context across studies.(54)Prognostic instruments have been proposed to identify patients likely to benefit, one scoring system for reconstructive surgery having been developed from a single-center cohort.(55)Between 2015 and 2024 reconstruction therefore became more biomechanically ambitious, with beaming and nailing replacing simple resection as the default in unstable feet, while the evidence that any one technique is superior to another remained absent.

Table 1. Synthesis of the evidence on Charcot neuroarthropathy of the foot by thematic axis.

Axis	Key findings	Representative studies
Diagnosis	Clinical diagnosis of a warm, swollen, insensate foot; Eichenholtz staging anchors diagnosis to late radiographs; MRI detects earlier activity and shortens TCC treatment; hybrid imaging assists the distinction from osteomyelitis; biomarkers remain experimental	Rogers 2008; Korst 2022; Gooday 2023; Lukkhoo 2024; Raspovic 2024; IWGDF 2024
Offloading	TCC is the reference standard; earlier offloading in stage 0 shortens treatment and reduces recurrence; removable and windowed devices offer alternatives; remission monitoring relies on temperature and radiographs; pharmacologic adjuncts unproven	Pinzur 2006; Gooday 2020; Schoug 2024; Prem 2024; Lasschuit 2024
Reconstruction	Reserved for ulceration, instability and non-plantigrade deformity; axial beaming and superconstruct plating for the midfoot; retrograde nailing for the ankle; external fixation for infection and multiplanar deformity; complication and amputation rates remain high	Grant 2022; Frøkjær 2021; Bajuri 2023; Regauer 2023; Mateen 2023; Meyer 2024

Note: MRI = magnetic resonance imaging; TCC = total contact cast; SPECT/CT = single photon emission computed tomography/computed tomography; IWGDF = International Working Group on the Diabetic Foot. Source: Prepared by the authors from the reviewed literature.

DISCUSSION

The objective of this review was to synthesize the evidence on the diagnosis, offloading and reconstruction of Charcot neuroarthropathy of the foot published up to 2024 and to trace the trajectory of each axis. The synthesis shows a field that converged on earlier diagnosis and earlier offloading, moved reconstruction toward biomechanically ambitious stabilization, and yet remained anchored to a largely observational evidence base in which the reference tools, the Eichenholtz stages and the total contact cast, have survived every challenge to their primacy. The trajectory is therefore one of refinement at the margins rather than replacement at the center.

The diagnostic axis changed more in emphasis than in substance. The Eichenholtz classification persists because it organizes treatment and communication, even though it describes destruction that has already occurred, and the 2024 reviews of classification reach the same conclusion.(13)The clearest advance between 2015 and 2024 is the normalization of magnetic resonance imaging as the instrument of early recognition, which the feasibility trial(19)and the retrospective series(17)both connect to shorter offloading. This aligns with the older clinical literature that warned against waiting for the radiograph,(56)and it explains why the international guideline now frames the diagnosis as clinical and probabilistic rather than radiographic.(11)The unresolved question is not whether magnetic resonance imaging helps but whether it can reliably separate active Charcot from osteomyelitis, and here the hybrid nuclear techniques provide incremental rather than decisive information.(18,20) The imaging reviews of the earlier decade already identified this as the central diagnostic problem,(57)which indicates that twenty years of technical development have not fully closed the gap.

The offloading axis illustrates how a recommendation can remain stable while its supporting evidence stays thin. The total contact cast has been the reference since the stage I series of Pinzur et al.,(58)and the 2024 guideline retains it,(11)yet the systematic review commissioned for that guideline found few comparative studies.(12)The most consequential recent finding is that

the timing of offloading, rather than the device, predicts the outcome, with stage 0 intervention associated with shorter cast treatment and less recurrence.(26) This converges with the stage 0 literature (22) and with the finding that early treatment avoids major amputation at one year,(27) and it diverges from the historical practice of observing the foot until the radiograph declared itself. The weight-bearing debate remains open because the systematic review could not resolve it,(25) and the alternative devices, from windowed casts(28) to protected weight-bearing orthoses,(29) are supported by series rather than trials. The absence of a validated remission marker is the axis's clearest gap, since the duration of offloading is otherwise a matter of judgement.(32)

The reconstruction axis shows the widest divergence between technical ambition and evidence. Axial beaming and superconstruct plating have transformed midfoot surgery,(41,42) and retrograde nailing dominates ankle reconstruction with measurable functional gains.(46,47) The comparative studies, however, are almost absent, and the one direct comparison of minimally invasive and open midfoot reconstruction found no clear superiority of either approach.(45) The complication literature is sobering: high rates of nonunion, hardware failure and infection after corrective arthrodesis,(52) residual amputation risk after reconstruction,(53) and substantial long-term mortality(51) all confirm that surgery trades one set of risks for another. This contrasts with the optimistic tone of technique reviews and indicates that patient selection, captured imperfectly by prognostic scores,(55) is the real determinant of benefit.

Compared with previous syntheses, this review finds continuity rather than rupture. The narrative reviews of Pinzur,(3) Frykberg and Mendezoon(4) and Rogers et al.(2) described the same triad of early recognition, prolonged offloading and selective reconstruction that the 2024 guideline restates.(11) What changed between 2015 and 2024 is the availability of earlier imaging, the accumulation of registry and cohort data on timing, and the diffusion of internal fixation techniques, none of which overturned the foundational concepts. The pathophysiological model has also matured without changing practice: the osteoclast-driven, cytokine-mediated acute phase described in the early molecular work(9) now anchors the pharmacologic trials,(36) but no antiresorptive agent has displaced mechanical offloading as the primary treatment. The persistence of the same conceptual frame across four decades of writing, from the classic reviews(3,4) to the 2024 guideline,(11) is itself informative: the disease has not changed, and progress has consisted of tools that detect and stabilize it earlier rather than of a new causal model.

The practical implication for the treating clinician is to compress the diagnostic and therapeutic delay: to image the warm insensate foot early, to offload in stage 0 rather than stage I or II, and to reserve reconstruction for the foot that fails conservative care, accepting that reconstruction does not restore a normal foot but a stable and shoeable one. The synthesis table maps these choices to their evidence, and the clinician should read the reconstruction rows with the complication figures in mind, because the benefit of surgery is conditional on the patient surviving and healing the procedure.

Three divergences recur across the literature and deserve explicit explanation. Studies of offloading timing disagree on the size of the benefit because they define stage 0 differently and follow patients for different periods, so the retrospective cohorts with the most favorable results are also the most exposed to confounding by indication.(26,27) Reports of reconstruction diverge on complication rates because they mix midfoot and ankle procedures, include or exclude infected cases, and follow patients for different lengths of time.(52,53) Imaging studies disagree on the marginal value of hybrid techniques because the reference standard for osteomyelitis varies between institutions.(18,20) In each case the divergence reflects measurement and population rather than a genuine contradiction in the underlying biology, which is why the synthesis weights the convergent findings, earlier offloading, earlier imaging and staged surgery in infection, above the individual estimates.

For podiatric and multidisciplinary diabetic foot services, the trajectory described here has an organizational consequence. The gains in early diagnosis and earlier offloading are realized only in services that can image the warm insensate foot promptly and cast it the same week, and the audit evidence shows that rural and nonspecialist settings lag behind specialist centers.(24) The reconstruction literature, by contrast, requires centralized surgical expertise, so the review implies a division of labor in which frontline services maximize early offloading and specialist units concentrate on salvage surgery for the failures of conservative care.(39) This distribution of roles is consistent with the multidisciplinary model proposed in the international guideline(11) and with the surgical literature that treats reconstruction as the last, not the first, step.(40)

A strength of this synthesis is its temporal organization, which makes the points of change explicit: the shift to magnetic resonance imaging around 2015, the accumulation of offloading timing data between 2019 and 2024, and the diffusion of beaming and nailing across the same

period. The narrative format also permits the comparison of technique reviews against complication series within the same axis, which a pooled estimate of a single outcome would obscure. These strengths come at the cost of reproducibility, and the review should be read as a map of the field rather than as a measurement of any single effect.

This review has limitations inherent to its narrative design. The search was not exhaustive, was restricted to English-language literature and to four databases, and did not formally assess the risk of bias of individual studies, so the relative weight assigned to each axis reflects the author's judgement rather than a reproducible scoring. The core window was limited to 2015 to 2024 by design, which may understate contributions published in 2024 in press at the time of writing. The English-language restriction is a particular limitation for a journal with a Latin American readership, because podiatric and orthopaedic experience from Spanish- and Portuguese-speaking services is underrepresented in the sources retained, and the findings should be read with this geographical skew in mind. Several of the practice-defining claims, including the timing of offloading and the superiority of fixation techniques, rest on retrospective cohorts in which confounding by indication cannot be excluded; readers should treat those claims as hypothesis-generating until prospective comparative data appear.

The agenda that follows from these gaps is concrete. Prospective registries should record the stage at diagnosis and the duration of offloading with standardized remission criteria, since this is the variable most plausibly responsible for outcome differences. Comparative trials of total contact casting against removable devices and of beaming against extended plating are feasible in specialist centers and would replace technique advocacy with evidence. Finally, the validation of a remission marker, whether skin temperature threshold, imaging-based or biochemical, would convert offloading from a duration determined by opinion into one determined by measurement. Progress on these fronts would benefit the Latin American and other settings in which specialist imaging and surgery are least available and in which a cheap, standardized marker would have the greatest practical value.

CONCLUSIONS

The diagnosis, offloading and reconstruction of Charcot neuroarthropathy of the foot advanced between 2015 and 2024 through earlier recognition, earlier offloading and more ambitious stabilization, while the conceptual frame established decades earlier remained intact. The Eichenholtz stages and the total contact cast persist as references, and magnetic resonance imaging, stage 0 offloading and axial or intramedullary fixation represent the main additions to practice.

The evidence base is dominated by observational series and small trials, and the questions that matter most to patients, which device, for how long, and which reconstruction for which foot, remain unanswered by comparative data. The clinical messages are nevertheless stable: recognize the warm insensate foot, image it early, offload it in stage 0, and reserve reconstruction for the stable, shoeable, salvageable foot after conservative care has failed.

Closing the remaining gaps requires prospective registries that record stage at diagnosis and offloading duration with standardized remission criteria, comparative trials of casting against removable devices and of beaming against extended plating, and validated remission markers. These steps would convert a practice still driven by expert opinion into one governed by measurement.

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