Charcot Foot: What do we really know?

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Charcot (CN): Clinical Appearance
**Etiology of the Foot Lesions**

Peripheral Vascular Disease (PVD)  
25%

Polyneuropathy (PNP)  
25%

Diabetic- Neuro-Osteo- Arthropathy (Charcot CN)  
45%

PVD+ PNP  
5%
Different Types of the Diabetic Foot

- PVD
- w/o infection
- CN + PVD
- Deformity
- Neuropathy
Wound Classification
acc. Wagner/Armstrong

<table>
<thead>
<tr>
<th>Stadien der Ulzerationen nach Wagner und Armstrong</th>
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<tr>
<td>mit Infektion</td>
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<tr>
<td>mit Ischämie</td>
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<td>mit Infektion und Ischämie</td>
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Wagner/Armstrong: 1A (?)

CN Sanders II

Osseous lesion?
DFS
p AVK

PNP
PNP mit Deformation
PNP mit DNOAP

pAVK mit PNP

Patient mit D. m.

D.m. + PNP
D.m. + DNOAP
D.m. + PNP + pAVK
D.m. + pAVK
CN really a rare Condition?

USA (2012)

- ADA estimation: 25 million people with D.m.
- 7.8% of population
- CN common complication of D.m.: 8.5 patients per 1,000 per year

Germany (2012)

Regionale Analyse der medikamentösen Behandlungsprävalenz und Arzneimitteltherapie von Diabetes mellitus in Deutschland

Regional analysis of drug treatment prevalence and medication of diabetes mellitus in Germany

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<thead>
<tr>
<th>Region</th>
<th>Diagnose</th>
<th>Medication</th>
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The Charcot Foot: Definition

- The hallmark deformity associated with this condition is midfoot collapse, described as a “rocker-bottom” foot. The condition can appear in other joints of the foot and ankle and with other presentations.
- Pain or discomfort may be a feature of this disorder during the acute stage, but the level of pain is significantly diminished compared to individuals with normal sensation and equivalent degrees of injury.
- The set of signs & symptoms that occur together w/ this condition qualifies it as a syndrome:
- Charcot foot syndrome

Nomenclature Committee’s Recommendation

- Charcot neuropathic osteoarthropathy (CN)
- Charcot foot
  - Charcot’s joint disease
  - Charcot arthropathy
- Neurogenic arthropathy
- Diabetic neuropathic osteoarthropathy

AETIOLOGY OF CHARCOT NEUROPATHY

- sensory neuropathy interfering with the RANK-L/OPG system as a possible explanation for an unleashed inflammatory response to a minor trauma or repetitive stress
- autonomous neuropathy with dysfunctional vascular control and opened AV shunts as a possible reason for local osteoporosis.
- motor neuropathy with paresis of intrinsic foot musculature and consequent development of foot deformity (claw toes, high arched foot) as a reason for increased static and dynamic loading

Perhaps 80% of all patients suffering from polyneuropathy (PNP) have a long standing diabetes mellitus, even if type 2 diabetes was diagnosed just recently.

Alcohol abuse is also contributory to PNP. An additive effect of diabetic metabolism and alcohol or nicotine as neurotoxins has not been examined yet.
Neurologic Examination is Key!
Classification of Charcot Neuroarthropathy (CN)

CN is classified after the **Topography** of affected joints and after the course of the disease. Localization is classified according to the Sanders system. The simplicity and practicability of this system imply its limitations, when more than one joint line is involved or when the topographic pattern deviates from anatomical lines (e.g., Lisfranc, Chopart). The Sanders classification system does not allow for deduction of a specific operative procedure from a radiological CN pattern.
Classification of Charcot Neuroarthropathy

The second classification was established by Eichenholtz in 1966 describing destruction as well as repair of joints and bone in the course of time. The stages are named “1 = destruction”, “2 = resolution” and “3 = coalescence”. This clinical (oedema, heat, reddening) and radiological staging system is well accepted internationally.

A “prodromal” stage “0” could represent a sensible modification in cases of bone bruise on MRI without manifest changes on plain x-rays. Another proposal is to subdivide stage “1” in “1a” with clinical signs of inflammation and bone bruise on MRI plus “1b” with additional osseous destruction visible on conventional radiography.
Charcot Sanders II, Eichenholtz O

Stage Eichenholtz 1A

XI/11

I/12
Ulcers often accompanying CN are best classified using the "University of Texas Wound Classification System". I to III describe ulcer depth; A to D tells if inflammation or ischemia is present in addition to polyneuropathy. Risk of amputation correlates well with the more severe stages (D III).

Category E should be introduced in case of dialysis, as practical experience shows a high failure rate of conservative ulcer treatment when end stage renal disease is present.

Medical history, clinical examination and conventional radiography (foot d. p., lateral, mortise view) is sufficient for making the diagnosis of CN. Affected bones and the extent of bone bruise and can be identified precisely with the help of MRI.

Any suspicion of *Eichenholtz* stage 0 (or 1a) must bring an MRI or a bone scan in addition to plain x-ray.

Therapy of Charcot neuroarthropathy is conservatively, on principle.

A deformed but **plantigrade foot** capable of full weight-bearing in a shoe or orthosis and without increase of deformity **is not a candidate for surgery.**

There is **not one single orthosis** for conservative treatment. Each device, TCC, prefab walker, CROW walker or individual AFO, has as different risk-benefit profile and has to be selected by the treating physician.
Infected CN are the worst cases!
To be precise, treatment is no longer targeted to neuro-arthropathy, but has to follow the Rules of septic surgery!
Even amputations or wide internal resections may be necessary.
An **acute Charcot** foot may call for in-patient treatment or **off-loading** by means of a wheel-chair over a period of **6-8 weeks**. After decrease of the acute inflammatory stage total weight relief may be replaced by **orthotic treatment** with particular emphasis on **rigid 3-dimensional fixation of foot and lower leg** including elimination of tibial rotation.

**Partial weight bearing is not feasible in the presence of PNP.**

Thus, guidance of weight bearing takes place by limitation of walking time.
Closed reduction and retention by means of cast of external fixator is ineffective in case of acute CN with joint dislocation and significant instability.

This subtype of CN can only be managed by open reduction and internal or external fixation (ORIF / OREF).

From a biomechanical point of view, the 2-column-model of the foot has to be taken into account. Fusion of the lateral column should be considered, even if the problem is confined to the medial column only. As soon as conservative treatment signals unfavourable outcome reconstructive surgery should take place without waiting for Eichenholtz stage III.
Charcot Typ Sanders III
Acute Dislocation Typ bilateral
Charcot Typ Sanders III
Acute Dislocation Typ bilateral
Recommendations for Surgical Treatment by ADA

1. **SURGICAL TREATMENT IS BENEFICIAL IN CASES REFRACTORY TO OFFLOADING AND IMMOBILIZATION OR IN THE CASE OF RECALCITRANT ULCERS.**

2. **INITIAL MANAGEMENT OF ACUTE NEUROPATHIC FRACTURES AND DISLOCATIONS SHOULD NOT DIFFER FROM OTHER FRACTURES.**

3. **EXOSTOSECTOMY IS USEFUL TO RELIEVE PRESSURE THAT CANNOT BE ACCOMMODATED WITH ORTHOTICS.**

4. **LENGTHENING OF THE ACHILLES TENDON** REDUCES FOREFOOT PRESSURE AND IMPROVES ALIGNMENT OF THE REARFOOT TO THE MID- AND FOREFOOT.

5. **ARTHRODESIS CAN BE USEFUL IN PATIENTS WITH INSTABILITY, PAIN, OR RECURRENT ULCERATIONS THAT FAIL NON OPERATIVE TREATMENT, DESPITE A HIGH RATE OF INCOMPLETE BONY UNION.**

6. **FOR SEVERE CN OF THE ANKLE, SURGICAL MANAGEMENT COULD BE CONSIDERED A PRIMARY TREATMENT.**
1. SURGERY AT A ACUTE PHASE IS INCONCLUSIVE (GRADE I).

2. MOST COMMON LOCATION MIDFOOT (59%) AND ANKLE (29%).

3. EXOSTECTOMY IS USEFUL TO RELIEVE BONY PRESSURE.

4. AT OR GASTROC REDUCES FOREFOOT PRESSURE AND IMPROVES ALIGNMENT OF ANKLE AND MIDFOOT (GRADE B).

5. ARTHRODESIS IS USEFUL IN PATIENTS WITH Instability, Pain OR RECURRENT ULCERATION THAT FAIL NON OPERATIVE TREATMENT, DESPITE A HIGH RATE OF COMPLICATIONS (GRADE C).

6. INCONCLUSIVE DATA EXIST TO THE TYPE OF FIXATION IN NON INFECTION CN (GRADE A).

7. ALTHOUGH SURGEONS WHO RECONSTRUCT CN MAY FEEL THAT SURGERY IS BENEFICIAL, NO STUDY HAS BEEN DONE COMPARING SURGICAL CORRECTION TO NON-OPERATIVE TREATMENT OR AMPUTATION.
Sanders I
(Brodsky neglected this type)
Sanders II: Lisfranc Joint

A rather common variation is perinavicular involvement and sometimes the neuroarthropathic changes are restricted to the medial or the lateral column. **Diverging Dislocations** are seen as well as deviations of all metatarsals to the medial or lateral side. A frequent pattern of deformity with this type of CN is forefoot abduction together with flattened medial arch and heel valgus.
Internal Fixation of Sander II may fail!
In case of inactive stage, realignment by means of 2- or 3-dimensional wedge resection is possible. Pure medial fusion may be indicated if the lateral column is spared.

Disagreement exists with respect to the optimal method of fixation, be it a frame, internal osteosynthesis or a combination of both. There is consensus that a particular stable fixation is necessary just as for Charcot surgery in general.

As any operation in case of inactive stage may lead to an acute exacerbation of neuroarthropathy, postoperative immobilization is obligatory by means of a cast or an AFO over a period of several months.
Are There Typical Destruction Patterns?
Sanders III: Chopart Joint

Combination with type II is quite common.

Typical deformity pattern for isolated type III is a rocker bottom foot with the Cuboid being the lowest part of the foot skeleton. The Talonavicular joint holds a key role for biomechanics, coupling the movements of foot and lower leg, making exact reduction and fixation challenging.

At least, inclusion of the Subtalar joint is advisable in order to minimize rotation forces acting on the talus. In case of doubt, triple arthrodesis is a guarantor for successful stabilization.

Length compensation between medial and lateral column requires subtractive arthrodesis.
Sanders III: Chopart Joint
Stable Internal Fixation

Sanders III > subtalare Fusion
Sanders II > Fusion laterale column
Unexplained:
- subtalar fusion in Sanders III in CN without mainfestation of CN in STJ
- Recommendation of osteosynthesis: intern +/- extern
- ATL always, when Gastroc or ATL
- Surgical technique: stabile T-N fusion, how?
Frontal plane deformities in the region of the hindfoot are hardly to manage conservatively, in particular in case of instability. Surgery aims at solid ankle fusion with broad contact area.

Astragalectomy may be a valuable option in the event of an extensive and rigid deformity in order to overcome soft tissue contracture.

Tibio-calcaneal arthrodesis in the following needs a months-long duration of orthotic aftertreatment with axial loading of the hindfoot.
Sanders IV: Ankle, Subtalar Joint
Instability: Charcot Sanders IV bilateral
Sanders V: Calcaneus

As long as the deformity is stagnant, conservative therapy is favourable, in particular in case of poor calcaneal bone quality with no support for screws or pins. If fragment distance of a calcaneal fracture is increasing due to pull of the Achilles tendon, treatment in a CROW walker or an AFO is ineffective or leads to a marked deformity. Surgery can be performed with a frame or with internal osteosynthesis, in particular with an intramedullary nail. If a nail has caused complications like septic or aseptic loosening with or without fracture, revision surgery can be done with external fixation. In case of impaired skeletal anchorage due to loss of bone substance external fixation surgery may be considered as primary treatment option.
Sanders V: Calcaneus
Conclusion

- Existing **classifications** define the CN insufficient

- Clinical **relevant destruction patterns** which lead to a defined treatment are **not to discover**

- Treatment of **Charcot Arthropathy** is mainly based on the **Experience of single Surgeons**

- Today's surgical therapy correspond to **Evidence Level IV: Good Medical Practice**
Thank You for Attention!