3.1 Diabetic Neuropathic Onychopathy (DNO)

(As per Dr. Adalbert Strasser, Specialist Surgeon, WundMED, Vienna, Austria)

Definition
Pathological change of the toenails due to diabetic foot syndrome with peripheral polyneuropathy.

Causes
In diabetic foot syndrome, the neuropathic component pathogenetically damages the nerves of the nail matrix causing nail growth dysfunction.

Appearance
The result is uncontrolled growth of the nail whereby the nail plate becomes unusually thick. Horizontal and longitudinal grooves develop on the nail and necrotic tissue deposits form between the underside of the nail and the cuticle.

This disorder is often diagnosed as onychomycosis and, if treated incorrectly, it can have a devastating impact for the patient since, in the worst case, amputation of the end phalanges is the only option.

Patients not only dislike the appearance of their nails, but also experience pain. Often convoluted nail growth is accompanied by pressure pain, cuticle irritation, and inflammation-triggering osseous tissue irritation of the end phalanges. In addition, the thickened nail plate can cause severe pain and foot static dysfunction, thereby changing the patient's movement pattern.

The unphysiological movement pattern caused by the neuropathic foot combined with toe deformity creates atypical pressure points, thereby overstressing the foot and increasing uncontrolled nail growth. Socks that are too small or improper footwear promote the pathological gait pattern. The metatarsal advancement in diabetic foot syndrome also contributes to neuropathic onychopathy.

Complications
Wound healing complications deriving from DNO pose a high risk for diabetics, especially injuries in the nail area.

Images 3.1 and 3.2
Diabetic neuropathic onychopathy

Incorrectly performed foot care damages the sensitive cuticle and can lead to the development of whitlow, non-healing ulcerations, subungual abscesses, fistula formation and osteomyelitis of the end phalanges.

Image 3.3 DNO with subungual ulcer

Image 3.4 DNO with subungual abscess

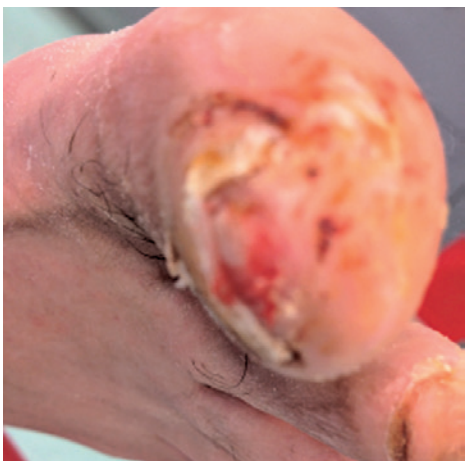


Image 3.5 DNO with subungual abscess-forming ulcer

Image 3.6 DNO with subungual pressure hematoma

Image 3.7 DNO with subungual pressure hematoma

Image 3.8 DNO with fistula-forming osteomyelitis preceded by a pressure ulcer

Image 3.9 DNO with osteomyelitis and abscess- and fistula-forming ulcer

Image 3.10 DNO with detached nail plate

Image 3.11 DNO with abscess-forming and beginning fistula-forming paronychia

Image 3.12 DNO with abscess- and fistula-forming paronychia

Image 3.13 DNO with abscess- and fistula-forming ulcer

Image 3.14 DNO with osteomyelitis of the left big toe's end phalanx showing an abscess- and fistula-forming ulcer

Image 3.15 Paronychia with abscess- and fistula-forming ulcer with osteomyelitis

Image 3.16 DNO with split nail plate

Image 3.17 Unguis convolutus

Treatment

To decrease pressure and pain, the thickness of the nail must be gradually reduced over a period of several months. The painful convoluted nails can be corrected with an adhesive non-wire brace using minimal activation force to avoid sulcus irritation. Applying tamponades aggravates the situation and can lead to the loss of the end phalanx. To rule out mycoses infestation, the affected nails should undergo a DNA analysis. If onychomycosis is present, treatment with Spirularin® is recommended. The active ingredient derives from the spirulina algae which fight bacteria, viruses and fungi. It is a gentle, natural and harmless substance yet very effective, which is proven by the results of many studies and practical experiences worldwide.

The above-mentioned treatment approach has helped me to improve the appearance of nails and to eliminate pain and discomfort for the patient.

The big toe is especially susceptible to pain and inflammation since it must absorb most of the pressure during movement. Close cooperation between diabetologist, orthopedic shoe maker and podiatrist is of the utmost importance.

In the acute phase a forefoot-relief shoe provides comfort for the patient but subsequently, wearing fitting orthopedic shoes is advisable since an arterial microcirculatory disorder aggravates the entire pathology.

Improper treatment can lead to limb loss.

If subungual abscesses with osteomyelitis of the nail plate are present, it is advisable to perform a sequestrectomy.

In addition to following sterile guidelines, frequent examinations, rinsing and strain relief are crucial.

The use of tamponades is discouraged since they host proteus and pseudomona organisms, according to Dr. Strasser's analysis of antibiograms. In case tamponade insertion is indispensable, it should never stay inserted longer than 24 hours and only sterile Ligasano® white tamponade should be applied.

Summary by Dr. Strasser
Due to the serious complications that are involved with nail disorders, diabetic neuropathic onychopathy is associated with diabetic foot syndrome. If fungi infestation is detected, it can be attributed to DNO syndrome.

DNO onychauxis with onychomycosis
With a beginning hallux rigidus and hammer toes, the nail thickness must be gently reduced over a longer period. An antimycotic treatment with spirulina algae extract and toe tape (if the toes are still flexible enough) provides relief.

Image 3.18 Close-up of DNO

3.2 Unguis incarnatus
(Greek: onychocryptosis)

The Latin name unguis incarnatus is more frequently used for an ingrown toenail (images 3.20 to 3.26).

Definition
Deeply embedded in the nail bed (image 3.21) with inward curved lateral nail edges (image 3.23) that are covered by the lateral nail wall. The front corners of the nail plate start to grow into the nail wall tissue (image 3.22) causing severe pain and inflammation if left untreated (image 3.23).

Causes
- excessive cutting of the nail corners
- pronounced transverse curvature of the nail plate caused by various factors
- changes of the nail plate's thickness and texture
- a reaction to a long-term inflammation in the nail fold, such as paronychia (tissue folds surrounding the nail), whereby the serous fluid dissolves part of the nail substance generating an uneven, partly jagged nail edge; this uneven edge prevents proper healing
- malpositioning of the foot or the toes, such as with hallux valgus, increase the damage
- wearing improper footwear
- diabetes mellitus, hormonal changes such as puberty or menopause, genetically determined sensitive skin

Various stages
- **Inflamed non-purulent:** Pressure applied by the deep lateral nail margin in the nail fold triggers inflammation displaying the classic signs, such as inflammatory reddening, swelling, pain, overheating and functional impairment in the nail fold and nail wall area.

Image 3.20 Unguis incarnatus with slightly lateral pressure pain

Image 3.22 Unguis incarnatus with painful inflammation

Image 3.21 Unguis incarnatus with slightly lateral and medial pressure pain

Image 3.23 Unguis incarnatus with granulation tissue and suppuration

- **Inflamed purulent:** The progressing inflammation promotes bacteria invasion through the widened nail fold causing acute paronychia (suppuration in the nail fold and under the nail plate). The purulent secretion often drains spontaneously or through applied pressure from the nail fold. The podiatrist can perform the initial treatment but must refer the patient to a physician for further treatment.

Image 3.24 Unguis incarnatus with slight lateral and medial pressure pain and minor inflammatory reaction

Image 3.25 Unguis incarnatus with slight lateral and medial pressure pain

Image 3.26 Unguis incarnatus with granulation tissue and medial suppuration

- **Inflamed purulent with granulation tissue:** In the progressed stage of the unguis incarnatus, granulation tissue develops. During the chronic inflammatory process, granulation tissue with its own blood circulation forms, so-called proud flesh. This granulation tissue has the tendency to grow exuberantly over the nail plate. Here too the podiatrist only performs the initial treatment and refers to the patient to a physician for further treatment.

Complications

Lymphatic vessel inflammation (lymphangitis often incorrectly identified as sepsis) can lead to necrosis of the toe if the inflammation is left untreated. The irritation of a sharp nail corner increases cell division and aggressive granulation tissue develops. For patients who suffer from diabetes mellitus or circulatory disorders, prolonged paronychia can lead to toe amputation.

Wound documentation

Every wound care treatment must be documented (image 3.27 see following page) in writing, a photo can be added to complete proper documentation (images 3.28 to 3.30).

Treatment

- Working with sterile instruments is of utmost importance.

> Cooperation with a physician is crucial.

- After thorough disinfection (e.g., with octenisept or Prontoman), check the nail margin for irregularities, hyperkeratosis and clavi with a probe, a double-end instrument or a blunt nail knife.
- Smooth out minor irregularities with a nail splitter, gauge, corner file or diamond-fissure grinding instrument.
- Cut the skin-penetrating nail tip in a V-shape and remove with a corner nipper, gouge, nail splitter or diamond-fissure grinding instrument making sure

Wound assessment

Patient's name _____

Wound status

Wagner 0-5
- ☐ 0 No open lesions; may have deformity or cellulitis
- ☐ 1 Superficial diabetic ulcer (partial or full thickness)
- ☐ 2 Ulcer extension to ligament, tendon, joint capsule, or deep fascia without abscess or osteomyelitis
- ☐ 3 Deep ulcer with abscess, osteomyelitis, or joint sepsis
- ☐ 4 Gangrene localized to portion of forefoot or heel
- ☐ 5 Extensive gangrenous involvement of the entire foot

Wound condition

Development and extent of the damage
- ☐ size
- ☐ depth
- ☐ involvement of deep lying fascia, muscle, tendon, cartilage and bone

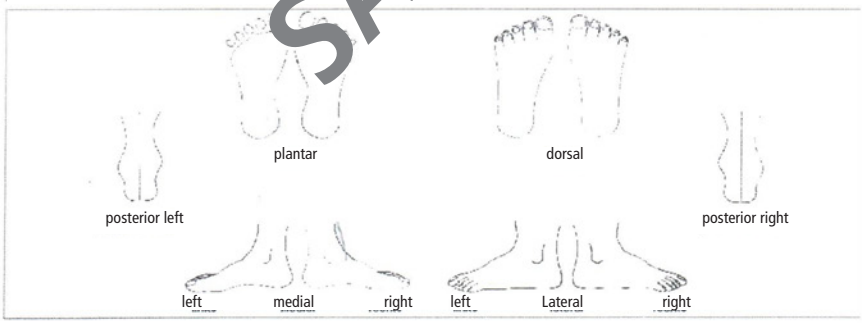
Condition of the wound margin
- ☐ smooth
- ☐ irregular
- ☐ jagged
- ☐ decayed
- ☐ wound pockets
- ☐ necrotic tissue portions
- ☐ condition of the necrosis
- ☐ closed black necrosis

Condition of the wound bed
- ☐ slough
- ☐ slimy tissue
- ☐ dirty
- ☐ presence of foreign bodies
- ☐ clean

Condition of the Exudation
- ☐ bloodied
- ☐ bloodied-serous
- ☐ purulent
- ☐ dried-up
- ☐ odour

Extent of bacterial Invasion and sign of Infection _____

How old is the wound? _____



Date Signature

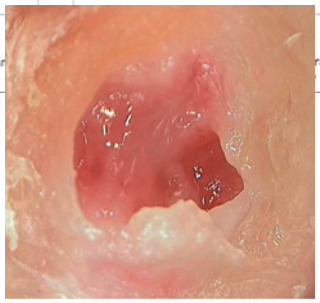


Image 3.27 Written wound documentation

Images 3.28 to 3.30 Wound documentation examples

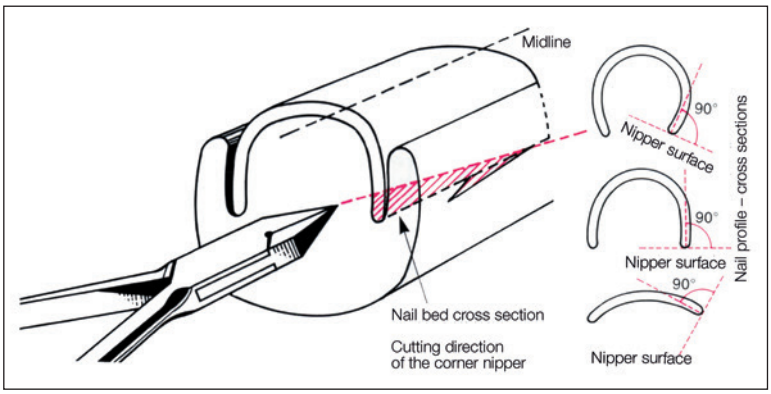


Image 3.31
Corner nipper cutting direction

Source:
Klaus Grünewald, Theorie der medizinischen Fußbehandlung, tome 1, 4th ed. 2012, Verlag Neuer Merkur

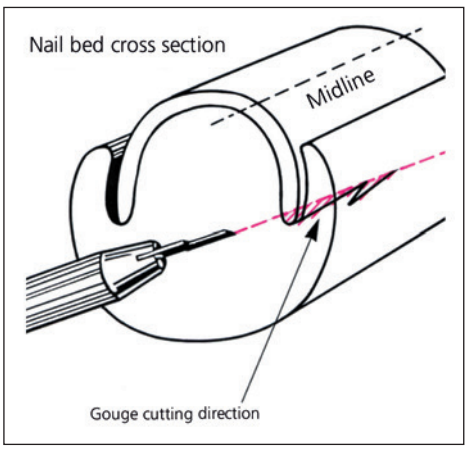


Image 3.32 Gouge cutting direction

Source: Klaus Grünewald, Theorie der medizinischen Fußbehandlung, tome 1, 4th ed. 2012,, Verlag Neuer Merkur

not to remove too much and not to leave sharp nail edges behind (images 3.31 to 3.34).

- Remove hyperkeratosis carefully from the sulcus with Prontoman spray (allow the spray to take effect for two minutes and, if needed, insert a thin spray-impregnated tamponade in the nail fold).
- For wound treatment in the sulcus area, use the following disinfectants: Pronto-Man gel, octenisept, Dolerma antiseptic nail fold oil, isopropyl 70 %, Calendula or colloidal silver.
- To stop potential bleeding, insert Clauden gauze or a gauze impregnated with a Policresulen concentrate solution, Copoline, fleece or cellulose strip into the fold and remove after three minutes. Nasal drops can also be used and are especially suitable for diabetic patients.
- After straightening the nail margin and removing sharp edges, insert Copoline or Ligasano tamponade in the nail fold.
- Apply nail correction braces, such as adhesive braces (BS brace, Gold brace (Goldstadt brace), Onychoclip brace, Erki brace) or spring-wire braces (Ross Fraser, 3TO, VHO, ORa). For how to properly attach the individual braces, see chapter 5.
- Apply a sterile dressing on the tip of the toe and ensure that there is no pressure applied to the toe.
- See the patient every day until the infection has subsided; following sterile guidelines is crucial.
- To promote faster healing, the patient can apply Spirularin nail serum on the nail and take frequent footbaths with sage, camomile, bran, thyme, horsetail or sea salt (one tablespoon in five liters of water at 37° to 38° C).

Prophylaxis

- correct cutting of the nail
- wearing properly fitting footwear
- careful cleaning of the sulcus with hyperkeratosis and clavus removal

Hygiene

- All infections are vulnerable to the invasion of the MRSA bacterium (methicillin-resistant Staphylococcus aureus). According to the Robert Koch Institute (German federal government agency and research institute responsible for disease control and prevention), the Staphylococcus bacterium has multiplied substantially. In 20% of the population, it is constantly detectable and in 50% of the population it is temporarily detectable. MRSA poses a high risk for patients with wound infections and a weakened immune system.

The German Federal Ministry of Health reports: "In Germany alone 400,000 to 600,000 people acquire nosocomial infections. These commonly called hospital-acquired infections are acquired during in-house or out-patient treatments claiming the lives of 7,500 to 15,000 people annually while traffic accidents are responsible for 3,475 deaths."

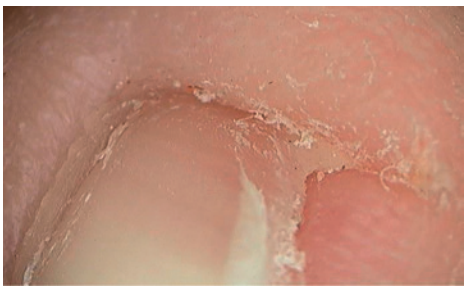


Image 3.33 Unguis incarnatus with painful inflammatory response (medial)

Image 3.34 After removal of the ingrown nail corner

Image 3.35 Pressure relief

Images 3.36 and 3.37 Improperly performed Emmert's procedure

Risk factors for the practice

1. latent risk to the podiatrist's own health and the health of other patients due to infection and bacteria transfer
2. the detection of MRSA within a practice can lead to its temporary closing; infected staff members must take sick leave and are not allowed to be in the practice environment
3. following the hygiene guidelines for patients infected with MRSA is crucial

The above risk factors demand the following special treatment and hygiene standards:

- full anamnesis
- MRSA hygiene plan and implementation of hygiene measures in the practice environment
- offering and recommending care and medical products (e.g., Spirularin foot gel, mousse and cleaning lotions, skinicer® sedative shampoo) to patients and staff members since these products protect against Staphylococcus aureus and, in particular, MRSA.
- Proper preventative measures, such as frequent hand disinfection and following standard infection control guidelines, help prevent the spread of MRSA infections (image 3.38).

Image 3.38 Hand disinfection

The guideline "At home follow-up care recommendation for patients with unguis incarnatus" can be found on the following page.