



## Original Research Article

# Toe nail changes in diabetes mellitus

P Vidyasagar<sup>1,\*</sup>, B Praveen Kumar<sup>1</sup>

<sup>1</sup>Dept. of Dermatology, Venereology and Leprosy,, Kamineni Institute of Medical Sciences, Narketpally, Telangana, India

### ARTICLE INFO

#### Article history:

Received 31-12-2020

Accepted 14-01-2021

Available online 22-02-2021

#### Keywords:

Nails

Diabetes mellitus

### ABSTRACT

**Introduction:** Diabetes is a metabolic disorder caused by abnormal release of or sensitivity to the insulin hormone, with loss of blood glucose control. Un controlled diabetes can have devastating effects on many organ systems including cardiovascular, neurologic, ocular, and renal, with its impact on skin, hair, and nail. diabetes mellitus is a predisposing factor for onychomycosis (OM), paronychia and ingrowing toe nail defects. In the present study evaluation of the prevalence and types of nail changes was done.

**Materials and Methods:** During a 1 year study period (June 2018 to May 2019), patients with diabetes mellitus were screened for toenail changes. Demographic, social, and clinical data were recorded. Informed written consent was taken. Fungal infection was confirmed by nail clippings microscopy.

**Results:** Of the 60 patients most common nail changes are subungual hyperkeratosis, onycholysis, and onychomycosis, and less common changes are Twenty nail dystrophy, Dorsal pterygium, Terry's nail in liver disease and diabetes mellitus and Subungual wart.

**Conclusions:** Physicians who care for diabetic patients should not ignore nail changes. Careful global evaluation of patients with diabetes should include observation of nail changes.

© This is an open access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

## 1. Introduction

Nails, though considered “dead structures,” have attracted attention since years ago. They occupy a very small area of the body, yet play a very significant role. Nails are made of keratin and grow lifelong. The nail plates protect the nail bed. The nail matrix – the living tissue which produces the nails – is visible as the lunula, the white crescent at the base of the nail. Under normal conditions, the mean growth rate of a fingernail is 3 mm/month and that of a toenail is 1 mm/month<sup>5</sup>.

Nails increase sensory perception at the finger pads, facilitate object manipulation and contribute to temperature regulation. Therefore, the fingernails take about 4–6 months to be completely renewed and the toenails take approximately double the time. Nail growth rate can nonetheless be influenced by several factors, including age, local and/or systemic disease and medications.<sup>1</sup>

Diabetes is a metabolic disorder caused by the abnormal release of or sensitivity to the hormone insulin, with loss of blood glucose control. Uncontrolled diabetes can have devastated effects on many organ system including cardiovascular, neurologic, ocular, renal, and cutaneous with its impact on skin hair and nails.

Nails not only have their own problems in the form of various diseases, but also act as a screen for different systemic illnesses like diabetes. being such a significant part of the body and incidence of the diseases of the nail claims a considerable portion of the total dermatological disorders in modern medical science, Various physiological as well as disease associated changes and disorders are seen in the diabetic nail. Many of these are extremely painful, affecting stability, ambulation and other functions like, tactile sensation, and protective function.<sup>2,3</sup>

The prevention and management of these conditions require periodic cutting of the nails and appropriate medical care. No physical examination in dermatology is complete

\* Corresponding author.

E-mail address: [sagarpappula@gmail.com](mailto:sagarpappula@gmail.com) (P. Vidyasagar).

without the study of nails, because most often the nail is a mirror of the underlying systemic disorders.

In spite of such a vital role, the nail still remains an understudied and underutilized.<sup>4</sup>

Hence this study was undertaken.

Periungual erythema and telangiectasis can be seen in the nail folds as an early finding of diabetes, thickening of skin of proximal nail fold can be seen in upto one quarter of diabetics.

Thickening of toe nails and even onychogryphosis can be related to micro angiopathic changes in chronic diabetes.

Pathogenic mechanism is mainly by Capillary morphological and functional abnormalities occur due to alterations in the function of endothelial cells on local flow regulation, as well as modifications of blood viscosity caused by higher plasma viscosity and increased erythrocytes rigidity and aggregation. Neuropathy and altered autonomous nervous contractile arteriole function and high vascular permeability also play a role.<sup>5</sup>

Microvascular walls of arterioles, venules, and capillaries are impaired by biochemical processes, which are based on hyperglycemia, namely non-enzymatic glycation of proteins and altered polyinositol metabolism. Glycation products also accumulate in structural proteins of the microvasculature. A specific macrophage receptor recognizes proteins to which glycation products are bound and stimulates their removal. Different pathologic processes are then activated, such as increase of endothelial permeability and stimulation of growth factor synthesis by macrophage. As a result, the vessel wall thickens and loses its elasticity. Later, the intensified glycation of hemoglobin leads to hypoxia, which is one of the prerequisites for microangiopathy.<sup>6,7</sup>

## 2. Materials and Methods

During a 1 year period (June 2018 to May 2019), and sample size of 60 patients with DM attending dermatology OP and out patients and in patients of other departments in tertiary-care hospital were screened by a dermatologist for any toenail changes. Data regarding demographic, social, and clinical history were collected, toenail care habits were recorded. Clinical data were confirmed and complemented with hospital records. Thorough observation of the feet and nails was performed. Changes in foot anatomy; callosities, were duly recorded. Routine investigations like RBS, complete hemogram, urine analysis were also done. Whenever fungal nail changes were observed, fungal tests were performed with samples of 1) subungual debris for mycologic examination, ie, direct microscopy of 40% potassium hydroxide preparations and culture are done.

Patients of any age and both sexes, with diabetes alone and diabetes with other systemic disorders are included. Patients with the diagnosis of DM for less than 6 months, unable to provide information due to comorbidities or

critical condition, or refusing to participate were excluded from the study.

## 3. Observation and Results

### 3.1. Subungual hyperkeratosis

Subungual hyperkeratosis is commonly seen in onychomycosis and in psoriasis, Subungual hyperkeratosis is the thickening of the stratum corneum of the nail bed and the accumulation of keratinocytes and debris under the nail plate.<sup>5</sup> The nail bed appears thickened and the nail plate is raised from the nail bed. It usually presents with onycholysis.

### 3.2. Onychomycosis

Onychomycosis, a fungal infection of the toenails and/or fingernails, is one of the most common diseases of the nail.<sup>8</sup> Onychomycosis affects toe nails more than finger nails because of their slower growth rate and reduced blood supply and occlusive foot ware, decreased immunity in old age is also a factor for its prevalence. Several risk factors for onychomycosis have been identified, including ageing, tinea pedis, psoriasis, genetic factors, peripheral arterial disease, peripheral neuropathy, trauma, swimming, smoking, immunodeficiency/immunosuppression, and diabetes.<sup>9,10</sup> Onychomycosis is a well-known complication of diabetes mellitus (DM). Diabetics acquire an increased likelihood of dermatophyte infections, especially on the nails; prevalence studies indicate that approximately one third of diabetics are affected.

*Trichophyton rubrum* is the most common keratinophilic fungi implicated in onychomycosis and tinea pedis. Other species include *Trichophyton mentagrophytes*, *Trichophyton tonsurans* and *Epidermophyton floccosum*.<sup>11</sup>

The most common clinical pattern is distal-lateral subungual onychomycosis.

Diabetic patients with onychomycosis have a threefold higher risk of gangrene and/or foot ulcers compared to those without onychomycosis.<sup>11</sup>

Physicians should educate their patients on the early signs of recurrence and recommend that they contact their physicians at the first signs of disease as likelihood of resolution improves when onychomycosis is detected and treated early.<sup>12</sup>

In the present study we got 26 onychomycosis cases out of 60.

### 3.3. Onycholysis

Diabetes may be associated with distal and/or lateral separation of the nail plate from the nail bed. It is more commonly seen affecting the fingernails than toenails. A greenish discoloration of the undersurface of the nail plate is indicative of a secondary infection by *Pseudomonas*

 <p>Yellow nail with onychogryphosis</p>	 <p>Yellow nail with onychodystrophy</p>	 <p>20 nail dystrophy</p>
 <p>Pincer nail deformity</p>	 <p>Onychogryphosis with deep fungal infection</p>	 <p>Nail pterygium</p>
 <p>Onycholysis</p>	 <p>Chronic paronychia</p>	 <p>Acute on chronic paronychia</p>
 <p>Onychomycosis</p>	 <p>Koilonychia with anemia</p>	 <p>Melanonychia</p>
 <p>Beau's lines</p>	 <p>20 nail dystrophy</p>	 <p>Onychauxis</p>
 <p>Onychomadesis</p>	 <p>Terry's nail in cirrhosis of liver</p>	 <p>Nail pitting in psoriasis</p>
 <p>Subungual wart</p>		 <p>Subungual hematoma</p>

Fig. 1:

**Table 1:** Age and gender wise distribution of nail changes

Age in years	male	Female	total	Percent
40 – 50	4	2	6	10
51 – 60	7	3	10	16.6
>/= 61	32	12	44	73
Total	43	17	60	

In the present study out of 60 patients 43 are males and 17 are females, of which 6 patients are between age of 40 – 50, Patients are of age >/= 61

**Table 2:** Spectrum of nail changes in diabetes patients. N=60.

S. No	Nail changes	Number of cases	Percentage
1	Subungual Hyperkeratosis	28	46.6%
2	Onychomycosis	26	43%
3	Onycholysis	24	40%
4	Onychauxis	21	35%
5	Yellow discolouration	20	33%
6	Onychorrhexis	16	26%
7	Beau's lines	6	10%
8	pitting in psoriasis with diabetes mellitus	5	8.3%
9	Paronychia	5	8.3%
10	Trachyonychia	4	6.6%
11	Ingrown toe nail	3	5%
12	Koilonychia with anemia and diabetes mellitus	3	5%
13	Pincer nail deformity	2	3.3%
14	Onychomadesis	2	3.3%
15	Onychogryphosis	1	1.6%
16	Twenty nail dystrophy	1	1.6%
17	Dorsal pterygium	1	1.6%
18	Terrys nail in liver disease and diabetes mellitus	1	1.6%
19	Subungual wart	1	1.6%

aeruginosa.<sup>13</sup>

Onycholysis was seen in 24 patients.

### 3.4. Onychauxis

Refers to enlargement and thickening of the nail plate without deformity, it as seen in 21 patients out of 60.

### 3.5. Yellow nail discoloration

One of the most common causes of yellow nails is fungal infection and also commonly seen in diabetic patients. As the infection worsens, the nail bed may retract, and nails may thicken and crumble. But in diabetics it is due to breakdown of sugar and its effect on the collagen in nails causing yellow coloration of nails.

If onychomycosis occurs in patients with diabetes, the chance of yellow nail discoloration would be double.

### 3.6. Onychorrhexis

It refers to brittleness of nails. Brittle nails are due to impair intercellular adhesion of the corneocytes of the nail plate, or

factors that cause a pathologic nail formation by involving the matrix. Characterized by longitudinal splitting of the nail plate. In our study we found 16 cases out of 60.

### 3.7. Paronychia

Acute Paronychia is often caused by bacterial infection or trauma to the nailfold of one digit. Repetitive trauma, excessive hand immersion in water contributing mechanisms by which separation of the cuticle from the nail plate may be obtained, facilitating the entrance of environmental particles and micro-organisms beneath the proximal nail fold. The presence of swollen and/or tender lateral or posterior nail folds with purulent fluid collections is diagnostic of acute paronychia.

Chronic paronychia usually arises as a multifactorial inflammatory reaction of the proximal nail fold to irritants and allergens lasting longer than 6 weeks.<sup>14</sup> Diabetes, Prolonged exposure to water, irritating substances, manicures, nail trauma, and finger sucking have all been implicated as predisposing factors.<sup>15</sup> Although candida is frequently isolated from the proximal nail fold of patients with paronychia.

In the present study chronic paronychia was seen in 5 patients out of 60.

### 3.8. Koilonychia.

The pathogenesis of koilonychia associated with primary dermatoses, sulfur-containing amino acids deficiencies, nail matrix changes due to blood flow abnormalities (age, nervous or vascular changes), endocrinopathies, iron-deficiency. And also due to the poor digital blood flow with successive weakening of subungual connective tissue, culminating in the depression of the distal matrix. Koilonychia was seen in 3 patients out of 60.

### 3.9. Ingrown nails

In this condition the lateral nail fold is penetrated by the edge of the nail plate, resulting in pain, infection and eventually the formation of granulation tissue. Ingrown nails are prevalent dermatologic abnormality seen in diabetic patients. Foot complications occur three to four times more often in diabetics than in non-diabetics controls<sup>16</sup> great toes are most commonly affected.

Ingrown toe nail was seen in 3 patients out of 60

### 3.10. Pincer nails

Pincer nail deformity, also referred to as omega nail deformity or trumpet nail deformity, represents a loss in the normal convex shape of the nail with an acquired thickening and transverse over curvature of the nail plate along its longitudinal axis.<sup>17</sup>

In the present study it was seen in 2 patients on great toe

### 3.11. Onychogryphosis

In this condition nail appears as “ram’s hornlike”, most likely involving the great toenail. Yellow, thickened nails are characteristic of long-standing diabetes.<sup>18</sup> It was seen in 1 patient who was suffering from deep fungal infection

### 3.12. Subungual Hemorrhages

Although common in otherwise healthy individuals, subungual hemorrhages may be observed in a variety of systemic diseases, such as diabetes mellitus. Subungual hemorrhage may serve as an indicator of diabetic microangiopathy severity.<sup>19</sup>

### 3.13. Terry’s nail

Terry’s nail describes a physical condition in which finger or toenails appear stark white with a dark band near the ends of the nails. Terry’s nails are observed in multiple conditions, including cirrhosis of liver, congestive cardiac failure, chronic renal failure, increased age and adult onset diabetes mellitus.<sup>20</sup>

Terry’s nails was seen in 1 patient with long standing diabetes with cirrhosis of liver

### 3.14. Other nail changes

Other nail disorders associated with Diabetes include pitting is seen in 5 patients who are having psoriasis, trachyonychia was seen in 4 patients, koilonychia with anemia was seen in 3 patients, onychomadesis was seen in 2 patients due to bullous pemphigoid, Twenty nail dystrophy in 1 patient, dorsal pterygium seen in 1 patient who had trauma and didn’t had any comorbidities, sub unguar wart in 1 patient.

## 4. Discussion

Diabetes mellitus is metabolic disease characterized by many skin changes and nail is one among them. Due to hyperglycemia there may be various systemic pathologic changes and metabolic events which affect nail unit structure and composition.

Chronic Diabetes can cause atherosclerosis of small blood vessels of toe which result in insufficiency of blood and oxygen supply to nail matrix resulting in change of shape, contour and color of nail.

Nail changes are relatively common in diabetic patients especially in chronic and insufficiently controlled diabetic patients, In our study we found high prevalence in nail changes due to patient related negligence and lack of care of nails, as Most of the patients attending the hospital were from the rural area and were agricultural laborers.

Other causes for prevalence were the use of common bathrooms in many homes and weighty manual work and agriculture work that bring patents in contact with soil, organic waste and dirty water, Limited studies are previously done related to nail changes in Diabetes patents.

In our study we found many abnormal nail changes in 31% of diabetic patents and compared with other studies though the studies are few on this topic.

In the present study nail changes we found is 19 types of different changes in 60 patients (31%) and in Gupta study it is 46%.<sup>8</sup> the less value in our study is due to lesser period of study.

### 4.1. Subungual Hyperkeratosis

We found highest nail abnormality is subungual hyperkeratosis, it is 46.6% (28 cases) and in Portugal study it is found 52%<sup>21</sup> which is near to our study. The less value in our study is due to lesser period of study. Subungual hyperkeratosis must draw attention of clinician for the possibility of onychomycosis.

### 4.2. Onychomycosis

The risk of onychomycosis is 2.77 times more in persons with diabetes compared with normal individuals.<sup>8</sup> We found

26 cases of onychomycosis with 43% which is second most nail change in our study, with Gupta study<sup>8</sup> it is 26%, and here our value is high, probably due to insufficient glucose control as the people are from rural areas and poor economic status for getting regular treatment, but a study from Akkus is 34.9%<sup>22</sup> which is very near to our study.

#### 4.3. Onycholysis

It is the third most common nail abnormality in our study

With 24 cases (40%) out of 60. The values in other studies like in Portugal study it is 30.7%<sup>21</sup> and in Gupta study it is 26%.<sup>8</sup> Our value is higher compare to both as most of our patients are manual workers from rural areas.

#### 4.4. Onychauxis

It is thickening of nail plate we found 21 cases with 35%, in a study by Dogiparthi it is 49%.<sup>23</sup> The values are nearly closure, but in Portugal study it is 16.9% only.<sup>21</sup> with Portugal study our value is high due improper care towards the nails given by the patients.

#### 4.5. Yellow discoloration

In our study we found 20 cases (33%) in the higher value is due to insufficient glucose control of diabetes and more number of aged patients ie 44 patients above 61 years.

Portugal study it is 29%, But in da silva MCA study it is found to be 52.7%.<sup>24</sup>

The Yellow discoloration of nails must alert the physician for the possibility of onychomycosis and should be differentiated from age related yellow discoloration.

#### 4.6. Onychorrhexis

In our study we found 16 cases with 26%, in Portugal study it is 20%<sup>21</sup> the both values nearly closer.

The remaining miscellaneous changes are Beau's lines- 6 cases (10%), Paronychia and pitting with psoriasis each 5 cases (8.3%), Ingrown toe nail and koilonychia each 3 cases (5%), Onychomedesis and Onychogryphosis each 2 cases (3.3%), Dorsal pterigium, Terry nails dystrophy, Twenty nail dystrophy and subungual wart each 1 case (1.6%).

### 5. Conclusion

Physicians who care for diabetic patients should not ignore nail changes because the prevalence of both diabetes and toe nail changes are high. Careful global evaluation of the patients with DM should, thus, include the observation of the feet and toenails. In some cases, nail changes are directive for the diagnosis, such as clubbed fingers in pulmonary or cardiovascular disorders. Before other signs of a systemic disease become clinically evident, nail changes may be a presenting feature.<sup>25</sup>

Toenail changes may indicate the need for general care measures, appropriate footwear, or foot deformity

correction, and antifungal treatment. Patients and their caregivers should be educated about nail care and the proper way of performing such care. These measures can help avoid breaks in the skin barrier, reducing the risk of bacterial infection and lower extremity ulcers and, ultimately, preventing additional comorbidity.

### 6. Source of Funding

No financial support was received for the work within this manuscript.

### 7. Conflict of Interest

The authors declare they have no conflict of interest.

### References

1. Tosti A, Jorizzo JL, Rapini RP. Dermatology. In: 1st Edn. London: Mosby Elsevier; 2005. p. 1061–78.
2. Drake LA, Dinehart SM, Farmer ER, Goltz RW, Graham GF, Hordinsky MK, et al. Guidelines of care for nail disorders. *J Am Acad Dermatol.* 1996;34:529–33.
3. Baran R, Dawber RPR. The nail in childhood and old age. In: Diseases of the nails and their management. 2nd Edn. Blackwell Scientific Publications; 1994. p. 81–96.
4. Babu KKR, Valia RG, Valia AR, Bajaj AK, Ganapati R, Girdhar BK, et al. Nail and its disorders. In: IADVL Textbook and atlas of dermatology. 2nd Edn. Mumbai: Bhalani Publishing House; 2001. p. 763–98.
5. Halfoun VL, Pires MLE, Fernandes TJ, Victor F, Rodrigues KK, Tavares R, et al. Videocapillaroscopy and Diabetes mellitus: area of transverse segment in nailfold capillar loops reflects vascular reactivity. *Diabetes Res Clin Pract.* 2003;61(3):155–60. doi:10.1016/s0168-8227(03)00111-6.
6. Bollinger A, Fagrell B. Clinical capillaroscopy—a guide to its use in clinical research and practice. Cambridge: Hogrefe & Huber; 1990. p. 166.
7. Lambova SN, Ladner UM. The specificity of capillaroscopic pattern in connective autoimmune diseases. A comparison with microvascular changes in diseases of social importance: arterial hypertension and diabetes mellitus. *Mod Rheumatol.* 2009;19(6):600–5. doi:10.3109/s10165-009-0221-x.
8. Gupta AK, Konnikov N, Macdonald P, Rich P, Rodger NW, Edmonds MW, et al. Prevalence and epidemiology of toenail onychomycosis in diabetic subjects: a multicentre survey. *Br J Dermatol.* 1998;139(4):665–71. doi:10.1046/j.1365-2133.1998.02464.x.
9. Finch JJ, Warshaw EM. Toenail onychomycosis: current and future treatment options. *Dermatol Ther.* 2007;20(1):31–46. doi:10.1111/j.1529-8019.2007.00109.x.
10. Tosti A, Hay R, Arenas-Guzmán R. Patients at risk of onychomycosis—risk factor identification and active prevention. *J Eur Acad Dermatol Venereol.* 2005;19(1):13–6.
11. Eba M, Njunda AL, Mouliom RN, Kwenti ET, Fuh AN, Nchanji GT, et al. Onychomycosis in diabetic patients in Fako Division of Cameroon: prevalence, causative agents, associated factors and antifungal sensitivity patterns. *BMC Res Notes.* 2016;9(1):494. doi:10.1186/s13104-016-2302-1.
12. Tosti A, Elewski BE. Onychomycosis: Practical Approaches to Minimize Relapse and Recurrence. *Skin Appendage Disord.* 2016;2(1-2):83–7. doi:10.1159/000448056.
13. Baran R, Dawber RPR. Diseases of the nails and their management. In: 2nd Edn. Boston: Blackwell Scientific; 2012. p. 513.
14. Rigopoulos D, Larios G, Gregoriou S, Alevizos A. Acute and chronic paronychia. *Am Fam Physician.* 2008;77(3):339–46.

15. Rockwell PG. Acute and chronic paronychia. *Am Fam Physician*. 2001;63(6):1113–6.
16. Erdogan FG, Erdogan G. Long-term results of nail brace application in diabetic patients with ingrown nails. *Dermatol Surg*. 2008;34(1):84–6.
17. Hernandez C, Deleon D. Acquired pincer nail deformity associated with renal failure. *J Clin Aesthet Dermatol*. 2011;4(12):43–5.
18. Rich P. Nail changes due to diabetes and other endocrinopathies. *Dermatol Ther*. 2002;15:107–10.
19. Chieb S, Baha H, Hali F. Subungual hematoma: clinical appearance of resolution over time. *Dermatol Online J*. 2015;21(10).
20. Nia AM, Ederer S, Dahlem KM, Gassanov N, Er F. Terry's Nails: A Window to Systemic Diseases. *Am J Med*. 2011;124(7):602–4. doi:10.1016/j.amjmed.2010.11.033.
21. Cunha N, Galhardas C, Apetato M, Lencastre A. Toenail Changes in Patients with Diabetes Mellitus with and Without Onychomycosis. *J Am Podiatric Med Assoc*. 2018;108(5):370–4. doi:10.7547/17-006.
22. Akkus G. Tinea pedis and onychomycosis frequency in diabetes mellitus patients and diabetic foot ulcers. A cross sectional - observational study. *Pakistan J Med Sci*. 2016;32(4):891–5.
23. Dogiparthi SN, Muralidhar K, Seshadri KG, Rangarajan S. Cutaneous manifestations of diabetic peripheral neuropathy. *Dermatoendocrinol*. 2017;9(1):e1395537. doi:10.1080/19381980.2017.1395537.
24. Silva MD, Mazzotti NG, Weber MB. Manifestações cutâneas em pacientes com diabete melito tipo 2 em posto de saúde. *Revista da Associação Médica do Rio Grande do Sul. Revista da Associação Médica do Rio Grande do Sul*. 2007;51:95–9.
25. Allevato MJ. Diseases mimicking onychomycosis. *Clin Dermatol*. 2010;28(2):164–77. doi:10.1016/j.clindermatol.2009.12.001.

### Author biography

**P Vidyasagar**, Associate Professor

**B Praveen Kumar**, 3rd Year Post Graduate

**Cite this article:** Vidyasagar P, Kumar BP. Toe nail changes in diabetes mellitus. *IP Indian J Clin Exp Dermatol* 2021;7(1):40–46.