

The diabetic hand: a very neglected pathology. A Case Study & Review of Literature

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Abstract

The term “diabetic hand” was born to describe the complications of the diabetes mellitus on the hand resulting in a rigid hand with a poor mobility. The traumatic wounds with soft tissue involvement increase the risk of infection. *Staphylococcus aureus* Methicillin-Resistant (MRSA) is the most common bacterium isolated in the hand infections. The case report of a type 2 diabetic patient, dialysed with chronic obstructive peripheral artery disease and Monckeberg sclerosis of the vessels of the hands, ischemic necrosis of the right-hand fingers is reported by the authors. In the diabetic patient the hands can be infected in the same way that feet could be infected too. Several amputation interventions have been performed with the intent of saving part of the hand.

The Diabetic Hand Syndrome (DHS) is an important pathology that requires strong antibiotics and surgery to avoid severe disability as rigidity, contracture and amputation. Apparently, in the last years good results are reported using antibiotic, surgical and hyperbaric treatment. In conclusion it would be wrong to ignore or underestimate this disease and any doctor should practice a scrupulous visit of the hands in the diabetic patient.

Keywords: Diabetic Hand; Gangrena of Meneley; Ischemia; Monckeberg’s Sclerosis; Sepsis

Introduction

The Diabetic Hand Syndrome (DHS) is definite as a clinical condition based on a vascular, neuropathic and infective pathogenesis caused by a chronic hyperglycemia with or without a pre-existing ischemia triggered by traumatic lesions of the upper limbs. Our impression is that in the last 20 years the interest about this pathology is going decreasing so that most of the doctors ignore the existence of this disease [1]. The term “diabetic hand” was born to describe the complications of the diabetes mellitus on the hand resulting in a rigid hand with a poor mobility. The immunodeficiency causes a higher risk of severe hand infections,

sometimes life-threatening. The outcome of the hand infection depends by the early diagnosis and treatment [2]. The morbidity of the DHS in terms of loss job, inability and permanent disability compared to the diabetic foot is sharply higher. However, in the last years the decreasing interest is proved by the poor scientific publications on the DHS [3]. The compact anatomy of the hand promotes a rapid propagation of the infection with severe damages. The etiology of the disease is multi-factorial. The traumatic wounds with soft tissue involvement increase the risk of infection. The most common bacterium is the staphylococcus (Table 1) but also other microorganisms can be involved both as single bacterium infection and as polymicrobial infection including Gram-bacteria (*Enterobacter*, *Streptococcus*, *Pseudomonas aeruginosa*, anaerobic bacteria and fungal infection) [4,5].

(a) Gram-positive organisms	Number of occurrences	%
<i>Staphylococcus aureus</i>	24	34
<i>Enterococcus spp</i>	6	8
<i>Streptococcus spp</i>	4	5.6
<i>Clostridium clostridiforme</i>	1	1.4
Total	35	49

(b) Gram-negative organisms	Number of occurrences	%
<i>Klebsiella pneumoniae</i>	5	7
<i>Citrobacter freundii</i>	5	7
<i>Morganella morganii</i>	4	5.6
<i>Enterobacter spp</i>	4	5.6
<i>Pasteurella multocida</i>	3	4.2
<i>Escherichia spp</i>	3	4.2
<i>Proteus vulgaris</i>	3	4.2
<i>Pseudomonas aeruginosa</i>	2	2.8
<i>Aeromonas caviae</i>	1	1.4
<i>Eubacterium lentiscus</i>	1	1.4
<i>Acinetobacter spp</i>	1	1.4
<i>Edwardsiella tarda</i>	1	1.4
<i>Xanthomonas multophilia</i>	1	1.4
Total	34	47.6

Table 1: (a) Gram-positive organisms in 57 specimens; and (b) gram-negative organisms in 57 specimens (from Lamm e Choi modified) [4].

Staphylococcus aureus Methicillin-Resistant (MRSA) is the most common bacterium isolated in the hand infections. The fungal infection can result in a trivial onychomycosis but also in a life-threatening disease if the infection is severe with deep layers involvement. The viral infections are rare, anyway sometimes Papillomaviridae, Herpesviridae, Picornaviridae (coxsackievirus and enterovirus) and Poxviridae (orthopoxvirus and parapoxvirus) were isolated in patients with DHS. In the study published by Lamm and Choi (2004) the 49% of the infections were caused by Gram+ bacteria and the 47,6% by Gram- bacteria. *Staphylococcus aureus* was the most common bacterium isolated in the hand infections (34%). *Enterococcus* was isolated in the 8% of the cases. The Gram- bacteria *Klebsiella pneumoniae*, *Citrobacter spp*, *Morganella morganii* and *Enterobacter spp* were isolated

respectively in 7%, 7%, 5,6% and 5,6% (Table 1) [4].

The DHS is more common in patients affected by diabetes mellitus type II rather than diabetes mellitus type I. Anyway, the early diagnosis and treatment are more important than the type of diabetes and not all of the symptoms are related to the diabetes. The natural evolution of the DHS is the fulminant sepsis due to the infection and to the progressive hand necrosis (Meleney's gangrene).

Review of the Literature

Usually the hand is in an advanced condition of palmar deep sepsis and/or soft tissue infection. Often a partial amputation must be performed and nevertheless the mortality rate is significant. The stereotypical sepsis characteristics in the diabetic hand of the tropical population were studied by Gill, et al. (2003) [6] and they suggested the term of "tropical diabetic hand syndrome". We have poor data on this syndrome that suggest poor results. The outcome data on the "tropical diabetic hand syndrome" are limited, but the information available generally suggests poor results. The study of Akintewe, et al. in 1984 [1] indicates that in 4 patients out of 5 a partial amputation was necessary. In the most representative study (31 patients in Tanzania), Abbas, et al. [6] shows that in the 13% of the cases a full arm amputation was performed with a significant mortality rate (13%). These patients would need a prolonged hospitalization with infusional antibiotics and 2/3 would need a surgical treatment (debridement, incision and drain or amputation).

Bacteria are the most involved microorganisms, but also fungal, viral and protozoal infections are described [3, 7]. In the diabetic hand infections Gram- bacteria were isolated in the 52% of patients. In the DHS Gram- infections were reported in 52% [8]. Gram- predominancy (*Pseudomonas* 10,6%, *Proteus* 7,8%, *Enterobacter* 5,7%), Gram+ bacteria (*S. aureus* 15,6%, *Streptococcus beta-haemolyticus* 12,1%, *S. viridans* 7,1%) were found in diabetic patients. *Candida albicans* was found just in the diabetic hand group (2,8%) (Table 2).

Organism	Diabetic hand		Non-diabetic hand	
	N	%	N	%
<i>S. aureus</i>	44	15.60%	58	37.70%
<i>S.epideridis</i>			24	15.60%
<i>Strept. β-Haem..</i>	34	12.10%	8	5.20%
<i>S. viridans</i>	20	7.10%		
<i>Enterococcus</i>			18	11.70%
<i>Pseudomonass</i>	30	10.60%	8	5.20%
<i>E.coli</i>	94	33.30%	18	11.70%
<i>K. pneumoniae</i>			6	3.90%

<i>Klebsiella</i> sp			4	2.60%
<i>Proteus</i>	22	7.80%		
<i>Enterobacter</i>	16	5.70%	4	2.60%
<i>Aerobes</i>	14	5%	6	5.20%
<i>Candida</i>	8	2.80%		

Table 2: Frequency of organisms isolated on culture.

The rate of Gram- bacteria was between 31-73% in workers [2]. Different groups of Gram- bacteria were reported in patients affected by diabetes. These groups include: *E. coli* 0,72-4,2% [2], *Proteus* (Vulgaris *Proteus* in 4,2%) [2], *Pseudomonas aeruginosa* (1,3-7,2%) [2], *Klebsiella* (3,5-7%) [2], *Enterobacter* (1,9- 5,6%) [2] and *Aerobacter aerogens* in 0,72% [2]. *Klebsiella* was the most common Gram- bacterium isolated jointly with *Staphylococcus* in polymicrobial infections (Jalil, et al.) [9] and *Klebsiella*, *Enterobacter*, *Proteus* and *E. coli*, were found in 25% of microorganisms by Belcher, et al. [10]. Connor, et al. [11] reported Gram- bacteria in 31% including *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Klebsiella*, *Serratia*, *Haemophilus*, *Enterobacter*, *Eichenella*, *Pasteurella* and *Neisseria*. Dorko, et al. [12] reported *Neisseria spp.*, *Staphylococcus Coagulase negative* between 5,7% and 12,6% (8); *Streptococcus spp* in 5,6-16% [2]. *Staphylococcus β-haemolyticus* were mostly *S. pyogenes* between 3,6 and 12,5% [2]. Dorko et al. [12] reported *Streptococcus β-haemolyticus* in 22,4%. Not-β-haemolyticus *S. Viridians* were found in 1,3% [7], 2,16% [7]. Stevenson, et al. [13] reported *S. faecalis* in 0,7%-1,7%. *Streptococcus agalactiae* was isolated in a patient with diabetic hand [2]. *Enterococcus* was isolated in four cases and in three of them it was *E. faecalis* (9%) [2], while

anaerobic bacteria were reported in 9%. Stevenson, et al. found *Bacteroides* in 5,9% and others anaerobic bacteria in 5,3% of hand infections. Lastly *Eichenella* in 2,7%, *Prevotella* (1,5%), *Peptostreptococcus* (1,2%) [2]. Connor, et al. [11] isolated anaerobic bacteria in 9% including *Clostridium perfringens*, *Bacteroides*, *Fusobacterium* and *Veillonella*. A fungal infection should be considered in the differential diagnosis of the hand infection in the immunocompromised patient or in a not-responder patient to the standard treatment. In the study published by Jalil et al in the 10,3% *Candida* was isolated [9] and it has been reported as associated with chronic paronychia. Viral infection was caused mostly by herpes simplex HSV 1 e HSV2.

Case Study

Mister F., 58 years old, is a little business owner with a long story of disease. He got sick with diabetes mellitus type 2 when he was 31 and at 48 started hemodialysis due to renal complications. In 1989 high values of glycemia (500 mg/dL), triglycerides (1500 mg/dl), cholesterol (700 mg/dL) were detected. In 1999, with a reported creatinine >9 mg/dL started hemodialysis 3 times/week. Since then arterial insufficiency begins with lower limbs ulcers and both feet finger amputations. In 2012 right leg trans-tibial amputation was mandatory and in the 2014 several right hand finger amputations were performed. In our patient, in addition to functional and angiographics diagnostic techniques, a simple hand X-ray highlighted that the hand's vessels were completely enclosed in a wide calcium shell coming up to vessels of the small phalanges (Figure 1) (Monckeberg's sclerosis, frequent around the arteries of the lower limbs, rare around those of the upper limbs).



Figure 1: (A) X-ray left hand (B) right hand.

Then we decide to perform a tissue debridement. The surgical treatment is very gentle as the small vessels disease is really nasty and irreversible, intractable, which conditions a perfusion however reduced, so it's primary to avoid high pressure tissue zone (tight stitches, folded flaps...) that could be the trigger for the ischemic necrosis. The use of dermal replacement based on ialuronic acid (HMPA®) (Figure 2). Allows a reconstructive surgery with functional preservation of the hand (07.01.2015).



Figure 2: Partial resection V finger with dermal graft bioconductive (HMPA®) (07.01.2015).

At the right hand, furthermore we perform a partial resection of the IV finger (01.03.2017) (Figure 3,4) shows at MRI the vascular and bone situation with evidence of vessels calcification (Monckeberg's sclerosis).



Figure 3: Partial resection IV finger (01.03.2017).



Figure 4: Hand MRI with vessels calcification.

One month after begins ischemic necrosis of the I finger (Figure 5) so a metacarpophalangeal joint resection is performed (5.4.2017) (Figure 6) with diaphyseal resection of the I metacarpus and closing using a sliding flap. Two months after we perform a surgical revision of the II finger (Figure 7) and a partial resection of the proximal phalanges (21.6.2017). The current situation is shown in (Figure 8).



Figure 5: Ischemic necrosis I finger (Monckeberg's sclerosis).

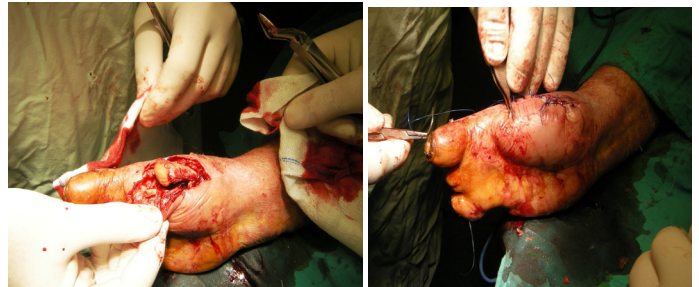


Figure 6: I finger metacarpophalangeal joint resection (5.4.2017).

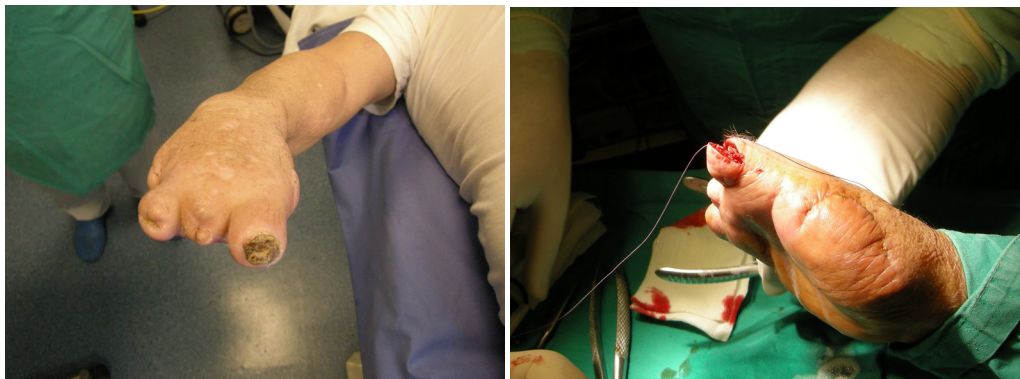


Figure 7: Partial proximal phalanges resection II finger (21.6.2017).



Figure 8: Current situation MRI 05/10/2017.

Discussion

Not everybody knows that in the diabetic patient the hands can be infected in the same way that feet could be infected too. (Montes de Oca 2008) [14].

Three are the causes of the ischemia in the dialysis patient's hand:

1. Arteriovenous fistula that steals oxygenated blood to the hand;
2. Big vessels disease that prevents blood from perfusing the hand;
3. Small vessels disease (metacarpal and digital vessels) acts as another obstacle to the hand's blood circulation.

The associated factors in the diabetic hand syndrome are similar to the associated factors in the lower limbs syndrome: 1. High levels of glycemia. 2. Neuropathy due to the hyperglycemia, metabolic pathway that leads to an increased intraneural sorbitol level. The not-enzymatic glycation determines a depletion of the myoinositol levels and ATP decreased levels and neuronal degeneration, slower conduction velocity and higher glycated haemoglobin, proving medium-high levels of glycemia in the last six-eight weeks. 3. The vascular theory: hyperglycemia causes reologic modifies with a subsequent increased endoneural vascular resistance, blood flow reduction and neural hypoxemia. 4. The diabetes mellitus is a risk factor for the arteriolar compromising and the atheroma making process, progression and complications

(stenosis, obliteration) with a decreased blood flow, perfusion pressure and ischemia. 5. Mechanical, chemical, physical, thermal or biological trauma are risk factors.

In our review, gram+ bacteria were isolated in the 50% of the hand infections and the most common bacterium was *S. aureus* (Tab. II). According to this result we use flucloxacillin and erythromycin in the first line treatment regardless to the fact that in the DHS Gram- bacteria were found too. Diabetes promotes infections and has negative aftermath on the carbohydrate metabolism and glycemia. Firstly, Mann and Peacock [15] noted a Gram- predominancy in DHS in 1977, subsequently Francel, et al. [16] had different results with a mixed culture grow (63%). These infections are related with a more severe tissue damage and secondary deformity. In 1998, in a 12 years study, Gunther [17] enlisted 128 diabetic patients. Mansigh and Sawh [18] used a double antibiotic therapy to destroy both Gram+ and Gram- bacteria. This predominancy inversion was not demonstrated in others high risk group as in the alcohol addiction and abuse, HIV patients, intravenous drugs addicts and steroids addiction. Kour, et al. [19] reported the negative effects of the gram- and mixed infections on the wounds. In the Lamm and Choi study, 3 out of 5 diabetic patients had a Gram- infection and required surgery and 2 or more fingertip amputations. It demonstrates the importance to choose the right antibiotics to treat Gram+ and Gram- infections. Gentamicin and penicillin penicillinase resistant (cloxacillin, ampicillin, penicillin G) combination could be the best first line treatment but the renal function and gentamicin blood levels must be monitored.

Conclusion

The diabetic hand syndrome is common in young-adult people, in diabetes mellitus type II with a poor metabolic control and subsequent high level of the glycated haemoglobin, therefore with a high risk of complications (neuropathy of peripheral arteries). Trauma is the trigger for the infection process, late diagnosis and treatment lead to a high amputation risk and to an increased morbidity and mortality. The surgical treatment should: save life, preserve the function and, lastly, look out for aesthetics. Based on evidences, we can divide the DHS in 4 phases: 1. superficial wound and ulcer, deep wound and ulcer, 3. Abscess and osteomyelitis, 4. Necrosis and gangrene. The DHS is an important pathology that requires strong antibiotics and surgery to avoid severe disability as rigidity, contracture and amputation. The success depends by an early diagnosis and antibiotic treatment in the first 24-48h with immobilization of the limb. If the infection is not under control the surgical option must be considered (incision, drain, debridment or amputation). The right choice of the antibiotics depends by the knowledge of the most common involved microorganisms. Once we know the microorganisms involved we should change the

antibiotics based on the antimicrobial susceptibility.

In the last 10 years the relation among risk factors, mostly diabetes mellitus and Gram- infections, has been studied. The Gram- infections can't be treated just with a first line antibiotic treatment but these patients should be treated in hospital to treat the hand infection and to optimize the metabolic control of the disease, also using insulin. Though the bacteria involved in skin and tissue infections are very common (Gram+, *Staphylococcus*, *Streptococcus*), sometimes bowel bacteria are involved (Gram- and an Aerobes). The first line treatment provides the use of broad-spectrum intravenous antibiotics and possibly the surgical drain in case of abscess. The late treatment increases the risk of amputation. In case of amputation or loss of function after surgery rehabilitation should be considered. Apparently, in the last years good results are reported using antibiotic, surgical and hyperbaric treatment. In conclusion it would be wrong to ignore or underestimate this disease and any doctor should practice a scrupulous visit of the hands in the diabetic patient.

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