

# Prevalence of neuropathy in the diabetic foot

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## ABSTRACT

**الأهداف:** لتبيان نسبة انتشار الأنواع المختلفة للاعتلال العصبي بين مرضى السكري المصابين بالقدم السكري.

**الطريقة:** أجريت دراسة ذات أثر رجعي على 229 مريض مصاب بالقدم السكري، والذين عولجوا في قسم الضغط فوق الجوي بمستشفى الأميرة هيا - العقبة - الأردن، خلال الفترة ما بين يناير 1997م وحتى يناير 2008م، حيث تبين بأنهم يعانون من أنواع مختلفة من الاعتلال العصبي. تم تشخيص الاعتلال العصبي بواسطة التاريخ المرضي لوجود الألم، والفحص السريري العصبي بواسطة غياب انعكاسات الكاحل وإنعدام الإحساس الجلدي الكمي.

**النتائج:** وجدنا أن 203 من 229 (89%) مريضاً كان لديهم نوع واحد على الأقل من أنواع الاعتلال العصبي، 171 من 203 (84.2%) من المرضى لديهم أعراض الاعتلال العصبي الطرفي، (11.8%) من المرضى مصاباً بأعراض الاعتلال العصبي المستقل المختلف، (2.5%) مريضاً كانوا قد شُخصوا كاعتلال عصبي أدنى، و(1.5%) كان لديهم اعتلال عصبي بؤري. بلغ متوسط عمر المرضى  $14.32 \pm 7.17$  عاماً. فقدان الإحساس الجوربي كان من العلامات القيادية للاعتلال العصبي الخارجي، حيث شكّل ما قيمته (77%) من جميع الحالات، تلاها أعراض تَوخُّز، حرقة، وشعور بالنخز الحسي حيث شكّلت ما قيمته (70%) من الحالات.

**خاتمة:** تعتبر أعراض وإشارات الاعتلال العصبي الخارجي من العوامل الأكثر أهمية عند لجوء مريض مصاب بالقدم السكري للاستشارة الطبية، ويجب أن يكون لدى المريض وعياً كاملاً حول أهمية العناية بقدميه. كما يجب على الطبيب أن يضع في عين الاعتبار أنه بتقدم عمر المريض المصاب وبازدياد عدد سنوات الإصابة بالسكري تزداد نسبة حدوث الاعتلال العصبي ويصبح من الضروري عمل الفحص السريري للكشف عليه مبكراً.

**Objectives:** To illustrate the prevalence of different types of neuropathy in diabetic patients with diabetic foot.

**Methods:** This is a retrospective study of 229 diabetic foot patients treated at Princess Haya Hospital Hyperbaric Department, Aqaba, Jordan from January 1997 to January 2008, who were found to have

different types of neuropathy. Neuropathy diagnosis was reached through investigating the patient's history by presence of pain, and clinical neurological examination, absence of ankle reflexes, and abnormal quantitative sensory testing.

**Results:** We found that 203 out of 229 (89%) patients had at least one type of neuropathy. One hundred and seventy-one out of 203 (84.2%) patients had symptoms of peripheral neuropathy, 11.8% of patients showed symptoms of different autonomic neuropathy, 2.5% of patients had been diagnosed with proximal neuropathy, and 1.5% had focal neuropathy. The mean age of diabetes in complicated neuropathy was  $14.32 \pm 7.17$  years. A stocking sensory loss was the leading symptom of peripheral neuropathy (77%) followed by symptoms of tingling, burning, or prickling sensations in 70% of patients.

**Conclusion:** Symptoms and signs of peripheral neuropathy are considered the most important factors when counseling the diabetic patient, who should be thoroughly informed on the importance of applying ample care to the feet. The physician should consider the patient's age and chronicity of diabetes, and as they increase, it becomes imperatively important to conduct clinical examinations for early diagnosis of neuropathy.

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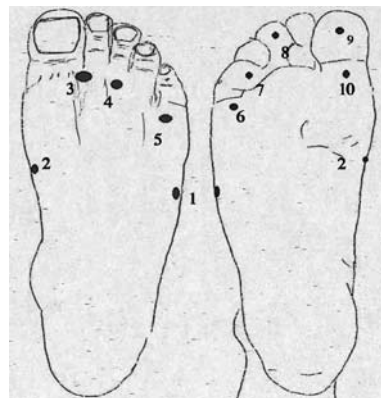
It is well recognized that diabetes mellitus (DM) impairs the efficiency of oxygen transport to tissues. Hyperglycemia may result in an increase in hemoglobin, causing oxygen to remain bound to the hemoglobin rather than circulating to surrounding tissues. In addition, capillary membranes appear to be thicker in people with diabetes, thus, cardiovascular disease at baseline was associated with double the risk of neuropathy, independent of cardiovascular risk factors.<sup>1</sup>

Progressive endothelial dysfunction, and loss of intra-epidermal nerve fibers occurs in the foot skin of diabetic patients with increasing neuropathic severity.<sup>2</sup> Diabetic peripheral neuropathy is a progressive neuropathy, initially involving the more distal parts of the lower extremities.<sup>3-5</sup> A cohort study by the Diabetes Clinic and the Diabetic Neuropathy Research Clinic at the Toronto General Hospital found that 69% of enrolled diabetic patients met the clinical criteria for the presence of diabetic sensorimotor polyneuropathy.<sup>6</sup> Neuropathy is the most common complication and greatest source of morbidity and mortality in diabetes patients.<sup>7</sup> Distal symmetrical sensorimotor polyneuropathy is the most commonly encountered form of diabetic neuropathy and is a common complication of DM.<sup>8,9</sup> Based on Limb Preservation Service (LPS) data, 83% of high-risk patients have peripheral neuropathy.<sup>10</sup> Two of the most common component causes of amputations are neuropathic foot ulceration and infectious complications of minor foot trauma.<sup>11,12</sup> This study shows the prevalence of different types of neuropathy in diabetic patients with diabetic foot.

**Definitions.** There are 4 types of neuropathy, peripheral, autonomic, proximal, and focal neuropathy. Members of an International Consensus Meeting on the outpatient diagnosis and management of DPN agreed on a simple definition of peripheral neuropathy as “the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes,” and proximal neuropathy is a predominantly motor disorder, usually encountered in elderly patients with muscle weakness and wasting, mainly affecting the proximal lower limb muscles.<sup>13</sup> The National Institute of Neurological Disorders and Stroke (NINDS) defines focal neuropathy as a progressive muscle disorder characterized by muscle weakness in the hands, with differences from one side of the body to the other in the specific muscles involved. Autonomic neuropathy affects the autonomic nerves that control blood pressure, the digestive tract, bladder function, and sexual organs.<sup>14</sup>

**Methods.** This is a retrospective study of 229 diabetic foot patients treated at Princess Haya Hospital Hyperbaric Department, Aqaba, Jordan, from January 1997 to January 2008, of which, 203 (89%) were found to have different types of neuropathy. This study was approved by the Human Research Ethics Committee of the Royal Jordanian Medical Services. This study was carried out on 229 diabetic foot patients who suffered from DM for a period of  $14.32 \pm 7.17$  years; 154 of which are males and 75 females with a mean age of  $55.98 \pm 5.67$  years. The studied patients suffered from different kinds of ulcers with below knee-

complicated wounds, with or without different levels of amputations. The patients were referred to the Princess Haya Hospital Hyperbaric Department from different hospitals in Jordan and neighboring Arab countries for hyperbaric oxygen therapy (HBOT) as the last pre-amputation choice. Neuropathy diagnosis was reached through investigating the patient's history by presence of pain, and clinical neurological examination, through absence of ankle reflexes, and abnormal quantitative sensory testing (QST). For documentation purposes, checklists were filled out in the process of investigating each patient. The checklist included specific data for symptoms and signs of diabetic neuropathy, and its location. The peripheral neuropathy diagnosis can be reached through investigating the symptoms shown, and physical examinations, which include but are not limited to; muscle strength check, ankle jerk reflexes, and sensitivity tests to position, vibration, temperature, and light touch. In addition to the above tests, 5.07 Semmes-Weinstein (SW) monofilament test was used.<sup>15-20</sup> The healthy foot is always tested first. Ten points are tested on each foot; 5 points on the planter aspect, 3 on the dorsal one, and 2 points at the medial and lateral aspect of the mid foot. The planter aspect points include; the heads of the first, third, fifth toes, and the bases of first and fifth toes. The dorsal aspect points include; the bases between the first and second toe, third and fourth toe, and fourth and fifth toe (Figure 1). The “yes” method was used during the testing, each time the patient senses the application of a SW monofilament; he or she has to say “yes”. If the patient missed out sensing 2 or more of the 10 points tested, he or she is defined as having diabetic sensory neuropathy. Patients with peripheral occlusive disease and with different contributing factors



**Figure 1** - Tests points of Semmes-Weinstein (SW) monofilament. 1 - Mid foot lateral aspect, 2 - Mid foot medial aspect, 3 - Between bases of the 1st and 2nd toes, dorsal aspect, 4 - Base of the 3rd toe, dorsal aspect, 5 - Base of the 5th toe, dorsal aspect, 6 - Base of the 5th toe, planter aspect, 7 - Head of the 5th toe, planter aspect, 8 - Head of the 3rd toe, planter aspect, 9 - Head of the 1st toe, planter aspect, 10 - Base of the 1st toe, planter aspect.

**Table 1** - Symptoms of peripheral neuropathy (N=203).

Symptoms	No. of patients	(%)
Tingling, burning, or prickling sensation	142	(70)
Stocking sensory loss	156	(77)
Sharp pains or cramps	7	(3.4)
Extreme sensitivity to touch	8	(3.9)
Loss of balance or coordination	13	(6.4)
Loss of ankle jerk	167	(82)

**Table 2** - Distribution of patients according to age.

Patient age	No. of patients
21-30	3
31-40	16
41-50	55
51-60	64
61-70	76
71-80	15

**Table 3** - Distribution of patients according to chronicity.

Years of chronicity	No. of patients
1-10	72
11-20	123
21-30	28
31-40	6

**Table 4** - Complications of neuropathy (N=203).

Complications	No. of patients	(%)
Ulcers	203	(100)
Amputation	46	(22.7)
Dislocation and pathological fractures	5	(2.5)
Charcot arthropathy	2	(1)

such as venous ulcers, pancytopenia, and patients with spinal nerve compression, were excluded from the study. In addition, other categories of patients were excluded from this study including; monofilament test non-cooperative patients, patients with large planter area hyperkeratinosis, and patients with wide ulcers.

**Results.** We found that 203 out of 229 (89%) patients had at least one type of neuropathy, and the other 26 (11%) patients had no symptoms of neuropathy. It is estimated that 84.2% (171 out of 203) of the studied patients had symptoms of peripheral neuropathy, 11.8% (24 out of 203) of patients had autonomic neuropathy, 2.5% (5 out of 203) of patients were diagnosed with

proximal neuropathy, and 1.5% (3 out of 203) of patients had focal neuropathy. These symptoms and signs included numbness, tingling, loss of ankle jerk and inability to feel in at least 2 out of 10 points of the SW test (Figure 1). Stocking sensory loss is the main symptom preceding the diabetic foot, followed by symptoms of tingling, burning, and or prickling sensation (Table 1). The incidence of paresthesia is obviously dependent on age and chronicity of diabetes (Tables 2 & 3). Around 11.8% (24 out of 203) of the studied patients showed symptoms of different autonomic neuropathy; 8.3% (2 out of 24) had Charcot foot, 12.5% (3 out of 24) had skin manifestations (mainly itching), 16.7% (4 out of 24) had retrograde ejaculation, 20.8% (5 out of 24) with bladder dysfunction, 41.7% (10 out of 24) had gastrointestinal problems (mainly constipation). Many complications can occur due to peripheral neuropathy; ulcers are the leading one, major infections can occur due to ulcers, which if not treated properly and timely can lead to amputations (Table 4).

**Discussion.** Although this study was conducted on a small group of patients, it indicates the great effect of peripheral neuropathy in inducing diabetic foot. A Jordanian study sample of 2836 subjects from the National Centre for Diabetes in 1998 showed that the overall prevalence rate of DM in males is 13.4%, and 12.5% in females.<sup>21</sup> The prevalence rate of DM in a Saudi study sample of 3,747 (1,683 males and 2,064 females) was 2.55% in males and 5.3% in females. In the age group of 35 and above, the prevalence rate in males was 8.5% and 19.4% in females.<sup>22</sup> In 2001, a study sample of 1142 patients at the National Centre for Diabetes in Amman, Jordan showed that the neuropathic patients displayed signs of impairment of vibration (19%), position (13%), and protective sense (18%).<sup>23</sup> Another Saudi study sample of 296 diabetic patients showed that 12.5% of the patients displayed signs of diabetic neuropathy.<sup>24</sup>

Although some literature emphasized the SW monofilament assessment only, in this study, most of the methods indicated in the international literature were used.<sup>15-20</sup> One similar Saudi study showed that trauma preceding infection was present in 20% of patients with diabetic foot, peripheral neuropathy was the main precipitating factor in 94% of them.<sup>25</sup> Armstrong et al<sup>26</sup> showed in their study that nearly 40% of subjects undergoing foot amputations had not been diagnosed either before or during admission with peripheral arterial occlusive disease, suggesting a causal pathway dependent primarily on neuropathy. Caputo et al<sup>27</sup> showed that peripheral neuropathy is present in approximately 80% of diabetics with foot lesions. Also, Faglia and colleagues<sup>28</sup> reported that the long-

term outcome of patients originally hospitalized in the period from 1990-1993 for diabetic foot ulcerations at a Milan hospital, was 83% of patients with sensorimotor neuropathy.

**Limitations of the study.** The limitations of SW monofilament are also clear. No matter what the instrument or procedure used, SW monofilament is only a semi objective measure, affected by the subject's attention, motivation, and cooperation, as well as by anthropometric variables. In retrospect, there are a few, specific limitations in this study that should be addressed as a means for improvement or potential strategies for further study. The first limitation focuses on the use of nerve conduction study required for accuracy assessment, but it is not available in our hospital. The second limitation is in the lack of HbA1c for accuracy measurement of controlled diabetes. The third limitation is in the lack of follow-up for those patients except for a small group of patients who live at the Princess Haya Hospital site, most patients are referred from other hospitals for HBOT.

In conclusion, distal symmetrical sensorimotor diabetic neuropathy is a common complication of DM, which leads to different kinds of amputations. Symptoms and signs of peripheral neuropathy are considered the most important factors when counseling diabetic patients, who should be thoroughly informed about the importance of applying ample care to feet. The physician should consider the patient's age and chronicity of DM, and as they increase, it becomes imperatively important to conduct clinical examinations for early diagnosis of neuropathy. More specified studies on peripheral neuropathy among patients with diabetic foot are needed.

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