FUNCTIONAL ASSESSMENT OF FEET OF PATIENTS WITH TYPE II DIABETES

Avaliação funcional dos pés de portadores de diabetes tipo II

Evaluación funcional de los pies de portadores de diabetes tipo II

Original Article

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ABSTRACT

Objective: To evaluate the incidence of functional changes and risk of developing ulcers in type II diabetic patients seen in Primary Healthcare Units (*Unidades Básicas de Saúde - UBS*). **Methods:** A cross-sectional, quantitative and descriptive study comprising 80 patients with type II diabetes mellitus (DM) aged between 41 to 85 years and attended in the PHU in the city of Parnaíba-PI. Volunteers responded to the identification form and the Michigan Neuropathy Screening Instrument (MNSI), followed by an evaluation of the lower limbs, as follows: achilles and patellar reflex, palpation of arterial pulses (dorsalis pedis and posterior tibial), tactile sensitivity (Monofilament 10g) and vibration sensitivity (128 Hz tuning fork); identification of the presence of changes such as ingrown toenails, calluses, claw toes and hair loss. Finally, using the information acquired from the assessment, subjects were classified according to the risk of developing wounds. **Results**: The sample consisted of 76 diabetic patients, with average age of 63.8 ± 10.4 years, 63 (82.8%) were female, mean diagnostic time 8.8 ± 7.2 years, average body mass index (BMI) 28.2 ± 5.4 kg/m2, with 15.7% of the sample being smokers. The myotatic reflexes and arterial pulses were reduced. Tactile sensitivity was identified in 81.5% and 13.1% did not feel the vibration of the tuning fork. The most dominant changes identified were calluses, 76.3% (n = 58). Risk level 2 of developing ulcers stood out, 52.6% (n = 40). **Conclusion**: Functional changes were detected in the sample and a classification of risk 2 for developing wounds was found in more than 50% of the assessed patients.

Descriptors: Diabetes Mellitus; Diabetic Neuropathies; Diabetes Complications.

RESUMO

Objetivo: *Avaliar a ocorrência de alterações funcionais e o risco de desenvolver úlceras nos pacientes diabéticos tipo II atendidos em Unidades Básicas de Saúde (UBS).* **Métodos:** *Realizou-se estudo transversal, quantitativo e descritivo com 80 portadores de diabetes mellitus (DM) tipo II que apresentavam idade entre 41 e 85 anos e frequentavam as UBS do município de Parnaíba-PI. Os voluntários responderam ao questionário de identificação e ao Michigan Neuropathy Screening Instrument (MNSI), seguido da avaliação dos membros inferiores, sendo: reflexos aquileu e patelar; palpação dos pulsos arteriais (tibial posterior e pedioso); sensibilidade tátil (monofilamento 10g) e vibratória (diapasão 128 Hz); identificação da presença de alterações como unha encravada, calosidades, dedos em garra e queda de pelos. Por fim, utilizando as informações adquiridas na avaliação, os voluntários foram classificados quanto ao risco de desenvolver feridas.* **Resultados:** *A amostra foi composta por 76 diabéticos, com média de idade de 63,8±10,4 anos, sendo 63 (82,8%) do sexo feminino, com média de tempo de diagnóstico de 8,8±7,2 anos, média do índice de massa corpórea (IMC) de 28,2±5,4 Kg/m2, sendo 15,7% da amostra fumantes. Os reflexos miotáticos e pulsos arteriais apresentaram-se hiporreflexos e diminuídos, respectivamente. A sensibilidade tátil foi identificada em 81,5%, e 13,1% não sentiram a vibração do diapasão. A calosidade foi a alteração mais prevalente em 76,3% (n=58). O risco 2 de desenvolver úlceras se sobressaiu, 52,6% (n=40).* **Conclusão:** *Observaram-se alterações funcionais na amostra estudada e uma classificação de risco 2 para desenvolvimento de feridas em mais de 50% dos avaliados.*

Descritores: *Diabetes Mellitus; Neuropatias Diabéticas; Complicações do Diabetes.*

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RESUMEN

Objetivo*: Evaluar la ocurrencia de alteraciones funcionales y el riesgo de desarrollar úlceras en pacientes diabéticos tipo II asistidos en las Unidades Básicas de Salud (UBS).* **Métodos:** *Se realizó un estudio transversal, cuantitativo y descriptivo con 80 portadores de diabetes mellitus (DM) tipo II con edad entre los 41 y 85 años que frecuentaban las UBS del municipio de Parnaíba-PI. Los voluntarios contestaron al cuestionario de identificación y al Michigan Neuropaty Screening Instrument (MNSI), seguido de la evaluación de miembros inferiores, siendo: reflejos aquileo y patelar; palpación de los pulsos arteriales (tibial posterior y pedioso); sensibilidad táctil (monofilamento 10g) y vibratoria (diapasón 128 Hz); identificación de la presencia de alteraciones como uña enclavada, callosidades, dedos en garra y caída de pelos. Por fin y utilizando las informaciones de la evaluación, los voluntarios fueron clasificados en cuanto al riesgo de desarrollar heridas.* **Resultados:** *La muestra fue de 76 diabéticos con media de edad de 63,8±10,4 años, siendo 63 (82,8%) del sexo femenino, con media de tiempo de diagnóstico de 8,8±7,2 años, media del índice de masa corpórea (IMC) de 28,2±5,4 Kg/m² con el 15,7% de la muestra de fumantes. Los reflejos miotaticos y pulsos arteriales se presentaron hiporreflejos y disminuidos, respectivamente. La sensibilidad táctil fue identificada en el 81,5%, y el 13,1% no sintieron la vibración del diapasón. Las callosidades fueron las alteraciones más prevalentes con el 76,3% (n=58). El riesgo 2 de desarrollar úlceras se sobresalió, el 52,6% (n=40).* **Conclusión:** *Se observó alteraciones funcionales en la muestra estudiada y una clasificación de riesgo 2 para el desarrollo de heridas en más del 50% de los evaluados.*

Descriptores: *Diabetes Mellitus; Neuropatías Diabéticas; Complicaciones de la Diabetes.*

INTRODUCTION

Due to technological advance, a rapid increase in sedentariness has been observed in recent decades, standing out as an important risk factor for the emergence of pathologies such as diabetes mellitus (DM)[1], considered a relevant public health issue and characterized by a lack or inadequate function of insulin, raising blood glucose levels[2].

Hyperglycemia leads to the development of associated diseases and complications such as retinopathy, nephropathy, decreased joint mobility, peripheral diabetic neuropathy (PDN), among others[3]. Data from the World Health Organization (WHO) reveals that there are approximately 346 million diabetics worldwide[4], while the Brazilian Diabetes Society estimates that there are approximately 12 million people with this disease[5].

The PDN may eventually involve the autonomic and/or peripheral nervous system, causing considerable morbidity and mortality rates[6]. It manifests itself about 10 years after diagnosis of DM, affecting approximately 50% of patients[7]. Autonomic neuropathy presents as clinical signs dysfunction in sweating, tachycardia, orthostatic hypotension, diarrhea and vomiting[8]; and sensory motor neuropathy presents loss of the feet's protective sensation, gradually, from distal to proximal region, hyperalgesia, paresthesia and a feeling of cold feet[9]. Change in sensitivity associated with the motor impairments give rise to anomalous zones of pressure relief, making feet vulnerable to minimal trauma, which can lead to the onset of plantar ulcers[10].

The feet of diabetic patients are regarded as targets of most DM impairments and have a 25% chance of developing ulcers[11,12]. According to the International Consensus on the Diabetic Foot (ICDF), the diabetic foot is one of the most frequent complications resulting from a cluster of factors, including vasculopathy and neuropathy, as well as determining ulceration, infection and/or destruction of deep tissues[13], being primarily responsible for the high number of non-traumatic amputations in developed countries, besides generating a high disabling potential among the population[14]. Estimates show that an amputation due to complications of diabetes occurs every 30 seconds in the world[11].

Some researches have been developed targeting the early identification of risk of developing ulcers associated with other disorders such as vascular changes, feet deformity, reduced joint mobility and time since diagnosis of diabetes, with the aim of avoiding amputations[8,9,11,13,15].

Due to the high prevalence of this disease in the city of Parnaíba-PI, affecting 2,223 individuals[16], it is necessary to know the characteristics of the population, based on the functional evaluation of the feet. Given the above, the objective of this study was to evaluate the occurrence of functional changes and the risk of developing ulcers in type II diabetic patients seen at Primary Healthcare Units (PHU).

METHODS

The present study had a quantitative, cross-sectional, exploratory and descriptive approach. The population consisted of patients with type II DM, regardless of gender, with physical and mental autonomy, without cognitive and neurological disorders not related to DM, and possessed of independent walking. All subjects were residents in Parnaíba-PI and assisted by the PHU team responsible for the territory of their residence, in the same county where the evaluations were performed. Recruitment occurred during care provided by the HIPERDIA program, according to each PHU's own schedule, in the period from February to September 2012.

The public healthcare unit was selected by lottery, resulting in a unit of District 03, with 112 patients enrolled in the program. During the study period, it was decided to assess all the patients who attended the program, resulting in a total of 80 evaluated patients (3.60% of patients enrolled in HIPERDIA in the city of Parnaíba-PI). Thus, the sample consisted of 80 patients with type II DM aged between 41 and 85 years, being excluded four of them: three because they presented neurological sequelae and one who had the musculoskeletal system compromised, totaling 76 volunteers.

Assessments were performed individually in a private room of PHU, with minimal external interference, by one previously trained evaluator. Initially, patients responded to the identification questionnaire with questions related to demographic data and time since diagnosis of diabetes[17], and the Michigan Neuropathy Screening Instrument (MNSI), in an interview. The MNSI is considered a practical and easily applicable means, consisting of 15 questions, often employed to identify signs and symptoms of PDN, being the participants with scores greater than or equal to 8 classified as neuropathic patients[18].

Then, the physical evaluation of lower limbs was performed, bilaterally, with the patient sitting on a stretcher, their knees at an angle of 90° and feet parallel to the ground plane, in the following order: assessment of deep tendon (Achilles and patellar) reflexes[12,15], pulse palpation of posterior tibial[19] and dorsalis pedis arteries[15], followed by the tactile and vibration sensitivity tests.

Achilles and patellar reflexes were assessed using Buck hammer and classified as present, hyporeflexia or areflexia[20]. The pulse palpation of the posterior tibial and dorsalis pedis arteries was quantified as absent, diminished, and present, upon evaluation by the examiner[21].

The tactile sensitivity was verified with the use of the 10-grams monofilament of Semmes-Weinstein, and the vibration sensitivity was determined by tuning fork of 128 Hz[15,17,22,23]. Firstly, the monofilament and the tuning fork were applied in the hands of the participants, who stood with open eyes, to understand the test; soon after, the volunteer was asked to close their eyes and respond *yes* or *no* to the evaluator on the perception of touch. The monofilament was applied to the hallux, 2nd and 5th metatarsals[19,24], at three points in the forefoot, and one point in the midfoot and in calcaneus[17,22,25]. The tuning fork, in three locations: the hallux, medial malleolus and the tuberosity of the tibia of the lower limbs[15,17,23].

Goniometric evaluation of the ankle (plantar flexion and dorsiflexion) and the hallux (flexion and extension) [10,24,25] were performed, being verified the presence of other alterations, such as ingrown toenail, limping gait, appropriate footwear, hair loss, deformity and callosities[15]. Soon after the physical assessment of toes, patients were rated according to risk of developing ulcers, standardized by the ICDF. Presented Risk 0 (R0) those who had only a diagnosis of diabetes, Risk 1 (R1) who were identified with altered sensitivity, Risk 2 (R2) those with altered sensitivity associated to the presence of deformities and/or vascular abnormality, and Risk 3 (R3), which included the presence or history of wounds or amputation[13].

At the end of the evaluation, the subjects were informed about the physical state of their feet and received an explanatory brochure containing information about the diabetic foot complications and guidelines regarding the proper care to prevent future complications.

Data was presented by simple descriptive technique with continuous variables presented as mean and standard deviation and categorical variables presented as proportions.

This study followed the principles of Resolution 196/96 of the National Health Council and the procedures relating to data collection and processing received approval from the Federal University of Piauí (UFPI) Research Ethics Committee under protocol number 0244.0. 045000-11.

RESULTS

The sample of 76 diabetics, aged 41 to 85 years, with a mean of 63.8 (±10.4) years, was composed mostly of females - 82.8% (n=63) versus 17.1% (n=13) of male gender. The mean time since diagnosis of diabetes was 8.81 (±7.2) years and the mean BMI was 28.16 (±5.4) kg/m^2. Among these diabetics, 15.7% (n=12) were current smokers, being 33.3% (n=4) males and 66.6% (n=8) females. The number of former smokers accounted for 30.2% (n=23) of the sample, with an average of 11.56 (±8.9) years for time since cessation.

According to the MNSI, 50% (n=38) of the diabetic patients achieved a score equal to or greater than 8 and were identified with signs and symptoms of PDN.

Achilles and patellar reflexes were present bilaterally in most of the studied volunteers, as shown in Table I.

As for tactile sensitivity to the monofilament, 81.5% (n=62) presented with integrity and 18.4% (n=14) did not feel the touch of esthesiometer in at least 2 of 8 points assessed in their feet. In the assessment with tuning fork, 13.15% (n=10) did not feel the vibration in at least 01 of the 03 sites evaluated. On palpation of the posterior tibial and dorsalis pedis arteries, it was found that most of the volunteers had diminished pulses (Table II).

On the issue relating to associated disorders that increase the chances of developing plantar ulcers, the highest incidence was of callosities, present in 76.3% (n=58) of the

evaluated. The presence of ingrown toenail and limping gait was 44.7% (n=34) and 39.4% (n=30), respectively. Patients who had deformities, such as claw toe and/or hallux valgus, accounted for 34.2% (n=26); while hair loss was present in 22.3% (n=17) of the study population. Only 9.2% (n=7) of the volunteers presented themselves using appropriate footwear.

In goniometry conducted in the ankle joint and hallux, there was deficit of movement amplitude in ankle plantar flexion and in flexion and extension of the hallux (Table 3).

After all the evaluation, the subjects were classified according to their risk of developing wounds, shown in Figure 1.

Table I - Evaluation of patellar and Achilles deep tendon reflexes in type II diabetics treated at PHU the city of Parnaíba-PI. Parnaíba-PI, 2012.

	Deep Tendon Reflexes			
	Achilles		Patellar	
	Right	Left	Right	Left
Present	67.1% (n=51)	68.4% (n=52)	57.8% (n=44)	55.2% (n=42)
Hyporeflexia	23.6% (n=18)	23.6% (n=18)	27.6% (n=21)	27.6% (n=21)
Areflexia	9.2% (n=7)	7.8% (n=6)	14.4% (n=11)	17.1% (n=13)

Table II - Analysis of the presence of pedal and posterior tibial pulses in type II diabetics treated at PHU in the city of Parnaíba-PI. Parnaíba-PI, 2012.

	Arterial Pulses			
	Pedal		Posterior Tibial	
	Right	Left	Right	Left
Present	40.7% (n=31)	39.4% (n=30)	32.8% (n=25)	34.2% (n=26)
Hyporeflexia	51.3% (n=39)	53.9% (n=41)	57.8% (n=44)	56.5% (n=43)
Areflexia	7.8% (n=6)	6.5% (n=5)	9.2% (n=7)	9.2% (n=7)

Table III - Goniometry of the ankle and hallux of type II diabetics treated at PHU in the city of Parnaíba-PI. Parnaíba-PI, 2012.

	Ankle				Hallux			
	Plantar Flexion		Dorsiflexion		Flexion		Extension	
	R	L	R	L	R	L	R	L
Mean	24.3	27.1	21.6	21.03	33.7%	35.6	43.8	41
Standard Deviation	±10.2	±11.8	±9.09	±8.6	±13.7	±14.4	13.3	14.5
Reference Standards	45°		20°		90°		70°	

R = right; L = left

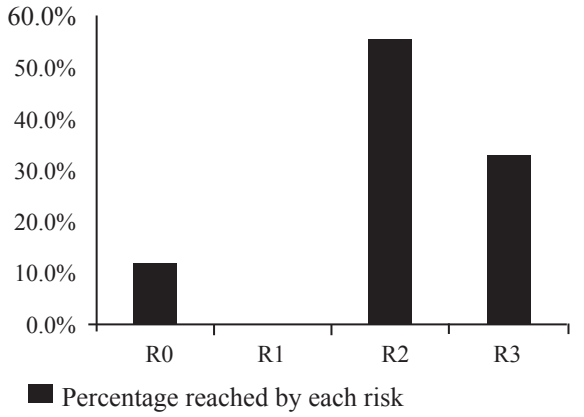

Figure 1 - Classification of the risk of developing ulcers in type II diabetics treated at PHU in the city of Parnaíba - PI.

DISCUSSION

The aim of this paper was to identify vascular, autonomic, sensory and motor abnormalities, to evaluate the risk of developing ulcers in type II diabetic patients who are assisted in the PHU of the municipality of Parnaíba-PI. The volunteers were aged between 41 and 85 years, with an average of 63.8 years and female predominance (82.8%). Among the aggravating factors of DM, time since diagnosis configures itself as highly relevant factor.

The course of the years after the discovery of the disease is characterized, if not properly treated, by the onset of complications that have serious consequences for patients with DM[6,13,14,19,25,26]. The mean time since diagnosis of diabetes in this study was 8.81 (±7.2) years, corroborating the findings of other authors, in which a diagnosis time over 8 years is closely related with the development of proprioceptive deficits and an increased risk of ulceration[19,21].

Obesity is of fundamental importance for raising the rates of occurrence of type II DM in adults[4,5,14,21,25], acting through a reduction in the number of insulin receptors on target cells[2], appearing around 40 years of age[14]. In the present study, the mean BMI of 28.16 (±5.4) kg/m^2 showed that members of the research found themselves overweight.

A research developed in Cuiabá-MT identified that 36% of diabetics were overweight, while 40% corresponded to the percentage of obese[27]. In a study conducted in Recife-PE, the overweight population accounted for 9% of cases of diabetic feet and obese subjects reached a higher percentage, 21.5% of cases[14].

Vascular impairment, observed by a decrease in arterial pulses in the lower limbs (LL), is an important finding in individuals with DM[9,17,21]. Evaluation of the pulses integrity is needed for the early identification of vascular involvement[16,21,28]. In one study, 13.3% and 13.8% showed no left and right pedal pulse, respectively. Changes in pulses of the left (25.2%) and right (26.1%) posterior tibial arteries were also found[21]. As for the present study, the most prevalent values referred to the condition of diminished arterial pulses. The decrease in the pulse of dorsalis pedis artery was identified in 51.3% of the right limbs and in 53.9% of the left limbs, whereas for the posterior tibial artery, 57.8% and 56.5% had decreased pulses in the right and left limbs, respectively. This fact suggests a poor peripheral circulation, hampering the response to trauma, as it hinders healing and favors the installation of infectious processes[1,5,7,8,19,21].

Smoking accentuates in an important way the decrease of the pulses, by causing the obliteration of arteries and arterioles, leading to early onset of peripheral arterial disease (PAD)[4,5,14,28]. In this study, 15.7% (n=12) of the assessed patients were smokers. In other study, 17.7% of the diabetics reported being smokers[27]; and a survey conducted in health centers of Ribeirão Preto-SP, 37.6% of them reported the use of cigarettes[28]. The present study showed a high number of former smokers, 30.2% (n=23), with an average of 11.56 years after kicking the smoking habits, reflecting an awareness for the adoption of healthy habits. Given the above, it can be inferred that there is a high percentage of diabetic smokers, favoring the development of vascular complications[26-28].

The limping gait and autonomic impairments are due to poor circulation[9]. The subjects of the current research with a limp accounted for 39.4% of the sample, and those who were identified with hair loss represented 22.3%, whereas another study[28] found 15.8% of assessed subjects with a limp. These values show that part of the population owns a significant vascular impairment and deserved attention[9,11,21,28]. The difference between studies occurred because most of the subjects studied in the city of Parnaíba-PI presented an advanced DM duration, favoring the onset of the complications found.

The patient with DM is usually affected with the reduction or loss of deep tendon reflexes (patellar and ankle) [25,26], due to sensory neuropathy and loss of proprioception[21]. Myotatic phasic reflexes are classified into normal, eliminated, reduced, lively or exalted. Occasionally, one can obtain smoothed or enhanced responses, even in the absence of the disease[20]. In another study, all subjects evaluated had the Achilles reflex preserved[17], while in the present research, evaluation covering the Achilles reflex revealed that he was absent in 9.2% (n=7) in the right limb and 7.8% (n=6) in the left limb, affecting bilaterally 23.6% of the assessed patients. The analysis of the patellar reflex in the current study showed that the percentage of areflexia

among those assessed was 14.4% (n=11) and 17.1% (n=13) in the right and left limbs, respectively, affecting bilaterally 27.6 % of the evaluated. These findings demonstrate a greater initial impairment of deep proprioception, due to the higher percentage of individuals with hyporeflexia, an involvement of afferent and efferent fibers of the muscle spindles[13,20].

The loss of sensation is another extremely important involvement for the patient with type II DM[10,13,15,17], whose complications stemming from its onset are numerous and may culminate in the most unwanted of all, amputation[11,14,19]. Evaluation of the integrity of protective sensation was performed in other studies, to assess the risk of developing ulcers, through the esthesiometer nd the tuning fork[10,12-15,19]. In the research in question, tactile sensitivity to the monofilament was preserved in 81.5% (n=62), while 18.4% (n=14) did not feel the touch in at least 2 of 8 points assessed. In another study, 40% of subjects who comprised the sample did not perceive the monofilament touching regions of heel and lateral forefoot, and underwent exercise sessions to the intrinsic muscles of the feet, but showed no progression of the insensitivity Picture on revaluation[10].

One study[17] evaluated the sensitivity of 55 diabetics using the tuning fork and 98.2% had it present; in our study, 13.15% did not feel the tuning fork's vibration. The characteristic gradual impairment of the NDP is evidenced primarily in the thin, slightly myelinated fibers responsible for tactile sensitivity. It then affects the larger caliber fibers, responsible for the vibratory sensitivity, which was observed in this study, where tactile sensitivity had a higher percentage of involvement than the vibratory one[10,13,20]. Again, the difference between the studies occurred because most of the subjects studied in the city of Parnaíba-PI showed an advanced DM duration, favoring the onset of the complications found[29].

The risk of decreased movement amplitude in diabetics rises proportionally to the values of glycated hemoglobin (A1c), to disease duration and age of the individual[24]. Despite these findings, given research[24] showed no significance in relation to the limitation of joint mobility in a group of diabetics and another of nondiabetics. The present study revealed values of ankle dorsiflexion near normal: 21.6% for the right foot and 21.03% for left foot. However, the values for the plantar flexion and extension and flexion of the hallux were below the reference standards, thus suggesting a greater impairment of the muscles involved in the execution of these movements.

In the present study, a high presence of factors such as ingrown nails (44.7%), calluses (76.3%), and deformities in the fingers (34.2%), which are closely related to the emergence of plantar ulcers, was found; Furthermore, only 9.2% reported using appropriate footwear. The use of improper footwear exacerbates the risk of developing ulcers because it does not make the correct and uniform weight bearing during gait[5,7,13,17,26]. In other study[28], the percentage of diabetics who used appropriate footwear accounted for 30.7% of the sample. Another study[19], where 72.4% of diabetics have made daily use of therapeutic footwear, revealed a lower recurrence rate of injuries in the feet of patients with type II DM who had suffered ulcers, demonstrating the beneficial effect of footwear that provides proper foot care. It is believed that the non-use of therapeutic footwear by subjects in the present study occurs due to lack of guidance and due to the high temperature of the region where they live. The subjects in this study who used appropriate shoes reported having been oriented by a health professional.

The classification proposed by the ICDF is important for the prevention of reversible factors that can improve the quality of life and reduce the risk of amputation in patients with type II DM[13,21]. In the present study, the R2 was more prevalent, with 55.2%, showing that this population has vascular impairment and protective sensibility compromise. Individuals with R1 were not identified in the sample. The reason why such results are shown may be due to the lack of sensitivity, which, at first, is not regarded as nuisance; only after the onset of complications such as ulcers, the diabetic begins to worry about the disease[7,10,14,17].

CONCLUSION

The type II DM patients in Parnaíba-PI have shown, mostly, being female, with a high average of time since diabetes diagnosis, in overweight status and a considerable portion of smokers. They present a relevant proprioceptive impairment, revealed by the identification of diminished or absent patellar and ankle reflexes, along with circulatory deficits evidenced by analyzing the pulses from the pedial and tibial arteries. The dermatologic and motor abnormalities, such as ingrown toenails, claw toes and\or hallux valgus and calluses, were evident, calling attention to the risks of ulcers that they trigger.

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