Evaluation of a new foam to increase skin hydration of the foot in type 2 diabetes: a pilot study

Nikolaos Papanas, Dimitrios Papazoglou, Konstantinos Papatheodorou, Efstratios Maltezos

Papanas N, Papazoglou D, Papatheodorou K, Maltezos E. Evaluation of a new foam to increase skin hydration of the foot in type 2 diabetes: a pilot study. Int Wound J 2011; doi: 10.1111/j.1742-481X.2011.00786.x

ABSTRACT

The aim of the present study was to evaluate the efficacy of a new product (Neuropad repair foam®) in promoting skin hydration of the foot in type 2 diabetes. Included in this study were 20 type 2 diabetic patients (10 men, mean age 61·40 ± 2·44 years). Patients applied Neuropad repair foam® on the plantar aspect of the right foot twice daily. No agent was applied on the left foot. Patients were examined at baseline, after 7 treatment days and after 14 treatment days. Evaluation of skin dryness was performed by means of the Multi Skin test Corneometer MC 900. In the right foot, skin capacitance was 26·55 ± 4·14 arbitrary units (a.u.) at baseline, 28·90 ± 4·53 a.u. after 7 days of treatment and 32·05 ± 4·54 a.u. after 14 days of treatment. There was a significant increase in skin capacitance from baseline to 7 days of treatment ($P < 0·001$), from baseline to 14 treatment days ($P < 0·001$), as well as from 7 to 14 days of treatment ($P < 0·001$). The same significant ($P < 0·001$) increases were observed both in men and in women. No changes were noted in the left foot. At baseline, there was no difference in skin capacitance between right and left foot ($P = 0·186$). However, skin capacitance was significantly higher on the right versus left foot, both after 7 days ($P < 0·001$) and after 14 days of treatment ($P < 0·001$). In conclusion, results with the new foam appear encouraging in ameliorating skin dryness in the diabetic foot and further investigation is warranted.

Key words: Diabetes mellitus • Diabetic foot • Skin • Xerosis

INTRODUCTION

The diabetic foot is a major cause of morbidity (1). Foot lesions ensue from a combination of three major pathologies: poor blood supply due to peripheral arterial disease, loss of protective sensation due to peripheral neuropathy and infection (1–3). Dry skin is a further precipitating factor (1,3). It is mainly induced by diminished sweating due to neuropathy and results in callus formation, especially in high-pressure areas (1,3,4). Ultimately, the skin may crackle and develop fissures, which are potential gates of entry for bacteria, thereby increasing vulnerability to ulceration and infection (1,3). Unsurprisingly, dry skin has very recently been shown in multi-variate logistic regression analysis to correlate very strongly with the presence of foot ulceration (5).

Treatment of dry skin in the diabetic foot encompasses the application of emollients to reduce xerosis (6–9), as well as regular removal

Authors: N Papanas, MD, Outpatient Clinic of the Diabetic Foot, Second Department of Internal Medicine, Democritus University of Thrace, Alexandroupolis, Greece; D Papazoglou, MD, Outpatient Clinic of the Diabetic Foot, Second Department of Internal Medicine, Democritus University of Thrace, Alexandroupolis, Greece; K Papatheodorou, MD, Outpatient Clinic of the Diabetic Foot, Second Department of Internal Medicine, Democritus University of Thrace, Alexandroupolis, Greece; E Maltezos, MD, Outpatient Clinic of the Diabetic Foot, Second Department of Internal Medicine, Democritus University of Thrace, Alexandroupolis, Greece

Address for correspondence: Dr N Papanas, MD, Outpatient Clinic of the Diabetic Foot, Second Department of Internal Medicine, Democritus University of Thrace, G. Kondyli 22, Alexandroupolis 68100, Greece

E-mail: papanasnikos@yahoo.gr

Key Points

- the diabetic foot is a major cause of morbidity
- foot lesions ensue from a combination of three major pathologies: poor blood supply due to peripheral arterial disease, loss of protective sensation due to peripheral neuropathy and infection
- dry skin is a further precipitating factor which is mainly induced by diminished sweating due to neuropathy and results in callus formation, especially in high-pressure areas
- ultimately, the skin may crackle and develop fissures, which are potential gates of entry for bacteria, thereby increasing vulnerability to ulceration and infection

international wound journal

Key Points

- urea-based creams have been shown to promote skin hydration effectively and safely
- a new foam with active ingredients Oenothera biennis oil, Centella asiatica extract, α-hydroxy acid, allantoin, and panthenol and 10% urea has now become commercially available (Neuropad repair foam®, TRIGOcare International GmbH, Wiehl, Germany)
- the aim of the present study was to evaluate the efficacy of the new foam in promoting skin hydration of the foot in type 2 diabetes
- this study included 20 type 2 diabetic patients (10 men, 10 women, mean age 61·40 ± 2·44 years, mean diabetes duration 8·20 ± 2·55 years)

of callus to reduce mechanical stress (2,3). Especially, urea-based creams have been shown to promote skin hydration effectively and safely (7,8). A new foam with active ingredients Oenothera biennis oil, Centella asiatica extract, α-hydroxy acid, allantoin, and panthenol and 10% urea has now become commercially available (Neuropad repair foam®, TRIGOcare International GmbH, Wiehl, Germany). Thus, the aim of the present study was to evaluate the efficacy of the new foam in promoting skin hydration of the foot in type 2 diabetes.

PATIENTS AND METHODS

This study included 20 type 2 diabetic patients (10 men, 10 women, mean age 61·40 ± 2·44 years, mean diabetes duration 8·20 ± 2·55 years). Patients were recruited from the Outpatient Clinic of the Diabetic Foot in the Second Department of Internal Medicine at Democritus University of Thrace, Greece. The study was conducted in accordance with the Helsinki Declaration of Human Rights and all patients gave their informed consent.

Exclusion criteria were as follows: age <18 and >70 years, peripheral arterial disease, acute or chronic Charcot osteoarthropathy, present or past foot ulceration, other potential causes of neuropathy (end-stage renal failure, alcohol abuse, vitamin B_{12} depletion, malignancy, peripheral nerve lesions), thyroid disease, drugs that might affect sweating (corticosteroids, anti-histaminic and psychoactive drugs) and skin diseases (neurodermatitis, psoriasis, scleroderma, allergy to metals, Raynaud syndrome, hyperhidrosia, acrocyanosis).

Patients were supplied with the Neuropad repair foam®. They were instructed to apply the foam on the plantar aspect of the right foot twice daily. No agent was applied on the left foot. Patients were examined at baseline, after 7 treatment days and after 14 treatment days. All examinations were conducted by the same operator between 1 March and 31 May 2010.

Evaluation of skin dryness was performed by means of the Multi Skin test Corneometer MC 900. This device measures skin capacitance, which is inversely related to humidity, and represents the most widely accepted modality of measuring the water content in the stratum corneum (10,11). The foot was tested in an area free from callus and hyperkeratosis in the middle of its plantar aspect. On every examination, three readings were recorded and the mean value was used for analysis. Examination was performed at constant room temperature (25°C) and humidity. Patients were allowed a 10-minute acclimatisation period after they had removed their socks and shoes. Examination was always performed in the morning. Patients had not used Neuropad repair foam® since the previous afternoon.

Statistical analysis was performed using the SPSS (Statistical Package for Social Sciences, Chicago, IL) 13.0. Normally distributed quantitative variables were analysed by paired *t*-test. Data were expressed as mean ± 1 standard deviation ($\bar{x} \pm 1$ SD). Significance was defined at a level of 5% ($P < 0{\cdot}05$).

RESULTS

In the right foot, skin capacitance was 26·55 ± 4·14 arbitrary units (a.u.) at baseline, 28·90 ± 4·53 a.u. after 7 days of treatment and 32·05 ± 4·54 a.u. after 14 days of treatment (Figure 1). There was a significant increase in skin capacitance from baseline to 7 days of treatment ($P < 0{\cdot}001$), from baseline to 14 treatment days ($P < 0{\cdot}001$), as well as from 7 to 14 days of treatment ($P < 0{\cdot}001$). In subgroup analysis, the same significant increases were observed both in men (baseline: 24·70 ± 3·74 a.u., after 7 days: 26·80 ± 4·13 a.u., after 14 days: 29·80 ± 4·08 a.u.; $P < 0{\cdot}001$ for each comparison) and in women (baseline: 28·40 ± 3·81 a.u., after 7 days: 31·00 ± 4·06 a.u., after 14 days: 34·30 ± 3·95 a.u.; $P < 0{\cdot}001$ for

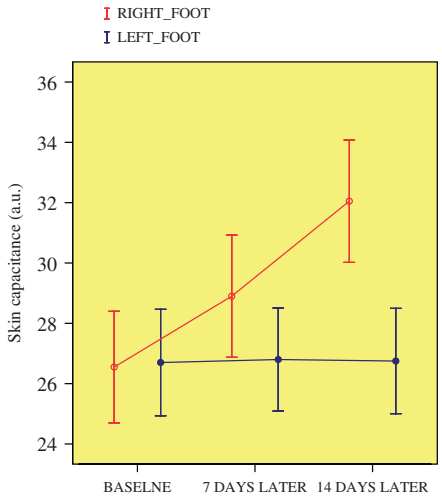

Figure 1. Skin capacitance at baseline, after 7 days of treatment and after 14 days of treatment in the two feet.

each comparison). At the end of the study, % increase in skin capacitance amounted to $20{\cdot}88 \pm 2{\cdot}85\%$. Increase of $\geq 20\%$ was observed in 16 patients (80%).

In the left foot, skin capacitance at baseline, after 7 days of treatment and after 14 days of treatment was $26{\cdot}70 \pm 3{\cdot}95$, $26{\cdot}80 \pm 3{\cdot}82$ and $26{\cdot}75 \pm 3{\cdot}91$ a.u., respectively (Figure 1). There was no difference between baseline and 7 days of treatment ($P = 0{\cdot}494$), between baseline and 14 treatment days ($P = 0{\cdot}748$), or between 7 and 14 days of treatment ($P = 0{\cdot}575$).

At baseline, there was no difference in skin capacitance between right and left foot ($P = 0{\cdot}186$). However, skin capacitance was significantly higher on the right versus left foot, both after 7 days ($P < 0{\cdot}001$) and after 14 days of treatment ($P < 0{\cdot}001$). Finally, all patients evaluated foam application as easy and pleasant.

DISCUSSION

This work has shown significant increases in skin capacitance in the feet treated with Neuropad repair foam® in comparison with the untreated feet. Measurement of skin capacitance is an established method for the estimation of skin hydration (12–15). This modality involves the evaluation of the changes in electrical properties of the stratum corneum, which the increased water content induces (12,13,16). By this method, novel results have been obtained at evaluation of Neuropad repair foam®. In particular, this foam has been shown to increase skin hydration. Impressively, a significant beneficial effect was noticeable as early as after 7 treatment days. It is also important that the effect was enhanced after further 7 treatment days. Furthermore, it was observed in both genders.

At baseline, there was no difference in skin capacitance between right and left foot. Following treatment, however, skin capacitance became significantly higher on the treated than the untreated foot. This change adds strength to the importance of treatment in promoting skin hydration.

In the treated feet, the average increase in skin capacitance at the end of the study was almost 21%. The majority of patients (80%) exhibited >20% increase. This cut-off is important, given that it has been proposed (though not yet universally agreed upon) as denoting a clinically meaningful improvement in skin hydration (15,16). Accordingly, the significant increase in skin capacitance following application of the foam appears to yield a clinically useful increment in skin hydration.

The limitations of this study may be outlined as follows. First, this was a pilot study recruiting a small number of patients, and so results need to be confirmed in a larger series. Second, patient follow-up was short. Therefore, future research also needs to address whether skin capacitance continues to increase further with prolonged application, as well as the optimal treatment duration. Moreover, this study was not placebo controlled. However, patients applied Neuropad repair foam® only on the right foot, while no treatment was performed on the left foot. This design enabled the evaluation of treatment, as compared to no intervention, in real conditions. Essentially, patients served as their own controls, so that the efficacy of Neuropad repair foam® in each of them became more manifest. Finally, patient recruitment was performed in a tertiary care setting. Hence, some caution is needed before applying the results to the general diabetic population.

The present study may have the following practical implications. In type 2 diabetic patients, the application of Neuropad repair foam® may be used to promote skin hydration. This is anticipated to protect the skin from callus and fissure formation, both well-recognised precipitating factors of diabetic foot lesions (1,3,5). Of note, the first evidence of improvement can be observed early in the course of treatment, while the prolongation of treatment appears to enhance this favourable effect. The efficacy of the foam may, probably, be ascribed to its active ingredients. Indeed, this foam contains not only 10% urea (7–9) but also Oenothera biennis oil, Centella asiatica extract and further beneficial components (α-hydroxy acid, allantoin, panthenol), which are known to promote hydration (17–20). In everyday practice, diminished skin moisture correlates with foot ulceration in diabetes (5), and the use of appropriate emollients to increase skin hydration is strongly recommended by international guidelines (21,22). Consequently, the new hydrating foam may be seen as a potential useful therapeutic adjunct for the diabetic foot. This potential utility is facilitated by its easy and pleasant application, according to the patients' own view.

Key Points

- this work has shown significant increases in skin capacitance in the feet treated with Neuropad repair foam® in comparison with the untreated feet
- impressively, a significant beneficial effect was noticeable as early as after 7 treatment days
- it is also important that the effect was enhanced after further 7 treatment days
- in the treated feet, the average increase in skin capacitance at the end of the study was almost 21%
- the majority of patients (80%) exhibited >20% increase
- this cut-off is important, given that it has been proposed (though not yet universally agreed upon) as denoting a clinically meaningful improvement in skin hydration
- the limitations of this study may be outlined as follows
- first, this was a pilot study recruiting a small number of patients, and so results need to be confirmed in a larger series
- second, patient follow-up was short, therefore, future research also needs to address whether skin capacitance continues to increase further with prolonged application, as well as the optimal treatment duration
- moreover, this study was not placebo controlled
- however, patients applied Neuropad repair foam® only on the right foot, while no treatment was performed on the left foot
- essentially, patients served as their own controls, so that the efficacy of Neuropad repair foam® in each of them became more manifest
- hence, some caution is needed before applying the results to the general diabetic population
- in type 2 diabetic patients, the application of Neuropad repair foam® may be used to promote skin hydration
- in everyday practice, diminished skin moisture correlates with foot ulceration in diabetes, and the use of appropriate emollients to increase skin hydration is strongly recommended by international guidelines
- consequently, the new hydrating foam maybe seen as a potential useful therapeutic adjunct for the diabetic foot
- this potential utility is facilitated by its easy and pleasant application, according to the patients' own view

In conclusion, the application of Neuropad repair foam® significantly increases skin capacitance in the foot of diabetic patients, suggesting an improvement in skin hydration. This beneficial effect is observed both in men and in women. Improvement is demonstrable as early as after 7 treatment days and becomes more pronounced after 14 treatment days. The present findings appear encouraging in ameliorating skin dryness in the diabetic foot and further investigation is warranted.

ACKNOWLEDGEMENTS

This study received no funding and was performed independently. NP has served as an advisory board member and speaker for TRIGOcare International GmBH.

REFERENCES

1 Boulton AJ. The diabetic foot: grand overview, epidemiology and pathogenesis. Diabetes Metab Res Rev 2008;24(Suppl 1):S3–6.
2 Edmonds M. The diabetic foot, 2003. Diabetes Metab Res Rev 2004;20(Suppl 1):S9–12.
3 Papanas N, Maltezos E. The diabetic foot: established and emerging treatments. Acta Clin Belg 2007;62:230–8.
4 Low PA. Evaluation of sudomotor function. Clin Neurophysiol 2004;115:1506–13.
5 Tentolouris N, Voulgari C, Liatis S, Kokkinos A, Eleftheriadou I, Makrilakis K, Marinou K, Katsilambros N. Moisture status of the skin of the feet assessed by the visual test Neuropad correlates with foot ulceration in diabetes. Diabetes Care 2010;33:1112–4.
6 Pham HT, Exelbert L, Segal-Owens AC, Veves A. A prospective, randomized, controlled double-blind study of a moisturizer for xerosis of the feet in patients with diabetes. Ostomy Wound Manage 2002;48:30–6.
7 Ademola J, Frazier C, Kim SJ, Theaux C, Saudez X. Clinical evaluation of 40% urea and 12% ammonium lactate in the treatment of xerosis. Am J Clin Dermatol 2002;3:217–22.
8 Lodén M. Urea-containing moisturizers influence barrier properties of normal skin. Arch Dermatol Res 1996;288:103–7.
9 Lodén M. Role of topical emollients and moisturizers in the treatment of dry skin barrier disorders. Am J Clin Dermatol 2003;4:771–88.
10 Triebskorn A, Gloor M. Noninvasive methods for the determination of skin hydration. In: Frosch PJ, Kligman AM, editors. Noninvasive methods for the quantification of skin functions. Berlin: Springer, 1993:57–80.
11 Distante F, Berardesca E. Hydration. In: Berardesca E, Elsner P, Wilhelm KP, Maibach HI, editors Bioengineering of the skin: methods and instrumentation. Boca Raton: CRC Press, 1995:5–11.
12 Lodén M, Lindberg M. The influence of a single application of different moisturizers on the skin capacitance. Acta Derm Venereol, 1991;71:79–82.
13 Jemec GB, Wulf HC. Correlation between the greasiness and the plasticizing effect of moisturizers. Acta Derm Venereol 1999;79:115–7.
14 Diridollou S, de Rigal J, Querleux B, Leroy F, Holloway Barbosa V. Comparative study of the hydration of the stratum corneum between four ethnic groups: influence of age. Int J Dermatol 2007;46(Suppl 1):11–4.
15 Lodén M, Andersson AC, Lindberg M. Improvement in skin barrier function in patients with atopic dermatitis after treatment with a moisturizing cream (Canoderm). Br J Dermatol 1999;140:264–7.
16 Dykes PJ. What are meters measuring? Int J Cosmet Sci 2002;24:241–5.
17 World Health Organization. WHO monographs on selected medicinal plants, Volume 1. Geneva: World Health Organization, 1999:77–85.
18 World Health Organization. WHO monographs on selected medicinal plants, Volume 2. Geneva: World Health Organization, 2002:217–30.
19 Tung RC, Bergfeld WF, Vidimos AT, Remzi BK. Alpha-hydroxy acid-based cosmetic procedures. Guidelines for patient management. Am J Clin Dermatol 2000;1:81–8.
20 Ullah OM, Sultana S, Haque A, Tasmin S. Antimicrobial, cytotoxic and antioxidant activity of Centella asiatica. Eur J Sci Res 2009;30:260–4.
21 Bakker K, Foster AVM, van Houtoum WH, Riley P, editors. International Diabetes Federation and International Working Group of the diabetic foot. Amsterdam: Time to Act, 2005.
22 International Working Group on the Diabetic Foot. International consensus on the diabetic foot & practical guidelines on the management and prevention of the diabetic foot. Amsterdam: International Working Group on the Diabetic Foot, 2007.