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RESEARCH ARTICLE

BANANA SKIN: WOUND HEALING ANALYSIS IN DIABETICS PATIENTS

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ABSTRACT

For the treatment of these wounds of diabetics patients it was proposed the analysis of these wound healing through the use of a gel made from the green banana skin per 10%.This studytook place in NAEENF (Nursery Assistance and Teaching Center) in the city of Pouso Alegre-MGand it was composed by 30 patients who used the gel from the green banana skin per 10% for one month. The results were the complete healing in 9 patients. The initial average of the wounds was 32,89 $mm^2$and it finished in the eighth collection representing 22,45 mm^2. The average was 19,94 $mm^2$for 10,30 mm^2. By making the central tendencies measures there was significance in the obtained general results of the whole group ($p<0,001$). We can conclude that the gel made from the green banana skin per 10% has a healing action in chronic ulcers presented by patients with diabetes.

INTRODUCTION

The Diabetes Mellitus (DM) is a major public health problem, being a chronic disease with high taxes of morbimortality which assails a big part of the popullation, and has as its causes hereditary and environmental factors. In Brazil, it is estimated that there are nearly 5 million of patients with diabetes, and almost half of it (46,5%) does not know the diagnosis. It is estimated that in 2020there can be 20 million of disease carriers, mostly due to the popullation aging, obesity and life style, associated to sedentariness and diet (Coelho *et al*., 2009). The DM occurs due to a disorder in the metabolism of insulin secretion and/or action, through the hiperglicemy and/or hiperinsulinemy. The diabetes type II is characterized by the chronic hiperglicemy related to the peripheral resistance of the cells to the action of circulating insulin, leading to factors that benefit the beginning of ulcers and delay of its healing (Minatel *et al*., 2009). The vascular complications associated to the DM are the fourth cause of death in the United States, and more than the half of the lower-extremity amputations. This stage is due to the chronic phase of the disease in which the sensorimotorneuropathy and the peripheral autonomic starts, generating alterations which can silent the sensibility and so create complications that the patient may not notice (Coelho *et al*., 2009). In Brazil, the DM has a prevalence estimated in 7,6% among people from 30 to 69 years old resident in urban zone and also this patology is the fourth biggest death cause in the country. This way, it is essential the early identification of the risk groups or the disease carriers by the health agents, besides promoting and intensifying the control of the already diagnosed patients in order to avoid bigger complications in the future (Coelho *et al*., 2009). Skin is the biggest organ of the human body, being essential for the survival and perfect physiological well-being of the organism. As any other organ of the human body, it is opened to not only internal but also external aggressions, due to pathological factors and traumas.

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Alterations in its structure can create skin injures and in some cases they can lead to its functional incapability. So, taking care of these injures is essential, through bandages or even through medicine use. The ulcers can be present at any age, gender or race, and also in pathology base carriers or not. The injures developed by patients with DM need to be treated in an appropriate way and the monitoring must be periodic (Morais *et al*., 2008). The healing constitutes a dynamic process of important tissue alterations in the maintenance of the organismo integrity, and it occurs in many phases: inflammation, chemo taxis, cell proliferation, diferentiation and remodelation. Patients with diabetes present alterations in the healing process, and it happens mainly in the first inflammatory phase which is characterized by vascular and cell events, so in these patients there will be a highlight in the edema, low vascular proliferation and a decrease in the cell elements, like leukocytes, macrophages and fibroblasts. As a consequence, there is a decrease in the collagen production, besides contibuting to increase the risk of local infection (Morais *et al*., 2008). The treatment costs related to scar defficiency are high, so researches to discover new medicine and bandages capable of acting in the areas with lesions are important. As it was mentioned before, the healing in patients with diabetes is deficiente and constitutes na important mundial issue, and according to data from the United States about 15% of people with diabetes develop more serious problems in relation to the healing, having difficult healing ulcers specially in lower extremity, what can lead to member amputation in some cases. Nearly 6% of hospitalization are related to these ulcers in patients with diabetes, and when it comes to amputation the hospitalization can last up to 3 weeks, and the costs vary from US$ 8.000,00 to US$ 12.000,00 per patient (Mendonça, 2009). In Brazil, 3% of individuals carry any type of skin wound, and this percentage increases to 10% in case of patients with diabetes who can even have their lesions contaminated with microorganisms as *Staphylococcus aureus* (Lima, 2011).

The use of plants in the prevention and healing of diseases is very old, probably since the beginning of civilization, and many were or still are used. Studies with *Aloe vera* and the green banana skin are being researched, but they need more studies. Other examples are the alcoholic extracts of the flowers of *Ixoracoccinea*, papain solution. Besides these, other studies are taking place aiming at analysing the skin wound healing through natural origin products (Lima, 2011). Banana is a widely used and easy access food, and lately its use in phytotherapy has increased, specially as an agent which improves the wound healing. The green banana is used as a healing agent in nipple fissures, through the intern scraping of the banana or even the skin on the local, with no need of interrupting the breastfeeding. In a study many portions of green banana were used in rats with ulcers caused by aspirin and demonstrate being effective both in prophylactic and healing treatment (Devereux, 1970; Best, 1984). Banana besides being highly nutritive also presents, based on scientific researches, other important functions as, for example, the gel of its skin per 4% promoted a big area of epithelization in wounds with secondary intention healing (Atzingen, 2011). It was discovered that the active factor (leucocyanidin flavonoid) present in the banana skin is water-soluble and that ripen bananas lose the therapeutic effect. The green banana extract acts both increasing the mucous density and in the thymidine incorporation to the DNA of the cells, showing its effect in the cell multiplication. The banana skin also contains other substances as fatty acids, phytosterols and carotenoids, and has proved antioxidant activity (Atzingen, 2011). With the increased number of scientific researches related to phytotherapics, there is a high interest in the discovering of new bioactive agents from lower cost and easy obtained plants and that may improve the life quality of the patients. Therefore, the study aim was to evaluate the wound healing in patients with diabetes who were treated with the green banana skin gel per 10%.

MATERIALS AND METHODS

This paper is characterized as individual, analytical, interventive, longitudinal, prospective, controlled and randomized clinical trial type 1. It took place in Assistance Center and Nursery Teaching (NAEENF), at Hospital das Clínicas Samuel Libânio,in the city of Pouso Alegre, Minas Gerais. There were in this study 30 patients of both genders with diabetes registered in NAEENF in the city of Pouso Alegre-MG with medical monitoring. We included in this study patients with lower-extremity skin lesions due to diabetes type II, patients diagnosed with diabetes by a doctor from the UAPS (Primary Health Care) or private older or at 18 years old and less than 80 years old and who agreed in taking part and signed the Free and Clear Term of Consent (TCLE). Patients who were absent in the treatment for once or more occasions, who gave up and who did not take part in the treatment or who presented allergies to the products were excluded from this study. The conglomerate sampling was used, randomly chosen from the study place. The green banana from the type *Musa sapientum* was used to prepare the material with the active substance, aaccording to VON LOESECKE (1950) scale, which classifies the bananas by its skin color. The scale relates the skin color to the level of the fruit ripening. The skin can be totally green, green with a little yellow, more green than yellow, more yellow than green, yellow with a little green, totally yellow and yellow with a little brown. For this study, we used totally green bananas, selected by the researcher (Atzingen, 2011; Von Loesecke, 1950).

The fruits were acquired straight from the producer, in the city of Pouso Alegre-MG, in the same selling way to the consumer. They were washed with running water from the Companhia de Saneamento de Minas Gerais (Copasa), to later peeling. After the washing, the bananas were left to dry in room temperature, on a clean cloth, for 20 minutes. After this time, they were washed again, with 500ml of distilled water, dried with white kitchen paper and left for more 20 minutes in room temperature. After that we took out and despised the pulp, to use only the skin. One whole skin of green banana is about 50g of crushed skin (Atzingen, 2011). After this process, the skin of green banana was cut in squares of nearly 1mmx1mm and put in a china bowl, where the manual crushing was made with a pistil, up to a complete homogenization, for 60 minutes obtaining the macerated. Afterwards, he macerated was weighin watch glassin the balance BG 2000-Gehakpara® (São Paulo, SP). To prepare the gel per 10%, we used natrosol gel from the trademark Botanik Kosmetics® (Campo Bom, RS).After the weight, the gel was added to the macerated of the green banana skin for more five minutes, for homogenization. To prepare 100g of gel, we used 10g of macerated from the banana skin added in 96g of the natrosol

gel basis. The prepared formulation was put in a white plastic recipient with a false bottom and capacity of 120g, previously sterilized, and stored in the fridge valid up to 30 days (Atzingen, 2011). The patients formed a group that used the green banana *Musa sapientum* skin gel per 10% together with a conventional treatment to wounds. The conventional treatment is washing the wounds with sink water and wound debridement. The debridement was manually made, with the help of a tweezers, scalpel blades number 13 or 15 and gauze to take out parts of the wounds and of devitalized tissue if necessary. The wounds were extremely irrigated with sink water (Dealey, 2008). During the experiment, patients went to the NAEENF to have the procedures done, being these the wounds cleaning with sink water, lesions debridement and application of the green banana gel per10%. The wounds were treated every three days, during 30 days, and were evaluated and measured on the day the patient was in the unit to have the bandage done. The gel was applied in the patients with the help of an individualized sterile bandage kit. The gel was uniformly put in the wound completely covering it. The Transpore® Johnson & Johnson (São Paulo, SP) of 15cm per 10m was firstly used, and as a second bandage, Micropore®, made specifically for this experiment. The evolution of the area was checked by the measure of the wounds contour, in sterilized acetate. Referring to the most external parts of the wound in the horizontal and vertical ways, a vertical and a horizontal lines were made so there was a 90ºangle between them, the values were pointed in millimeters. The comparison between the obtained values showed the wound real size, and the areas were photographed by a digital camera Power shot® A100, Cannon (Japan), 20cm from the lesion and on a tripod, aiming at evaluating the healing through a digital planimetry using the software Auto CAD 14®. The wounds evaluation were pointed and photographed by the researchers in front of the patients. The data collected macroscopically were tabulated in the Excel. To calculate the SPSS 17 was used.

The tabulated data were grouped, being that the descripitive analysis were obtained for the variable quantitative, through central tendencies measures (médium and mediane) and dispersion (detour pattern). In the achievement of the analytical procedures, for the central tendencies measures the paired Test t was used, for the parametric variable and non-parametric, Wilcoxon Test and Friedman Test were used. For accession verification to normality the Test Kolmogorov-Smirnov was used. The protocol was approved by the Ethics Comitee of UNIVÁS (Vale do Sapucaí University) with the CAAE 48017915.6.0000.5102and the Approval Report number 1.575.890.

RESULTS

In this study, there was not patint exclusion not even desistente. Any allergic reactions to the gel were mentioned neither any other symptom. The studied sample showed the following characteristics: 66,7% were male, 56,7% were White and 80% were more than 50 years old (average age 58,47 with detour pattern of 11,30 years). The variation of the wounds measure by the made collect is showed at Table1.From the 30 patients who started this study, 9 patients presented complete healing after the 4 weeks of evaluation. The initial average of the wounds was 32,89 $mm^2$and it finished in the eighth collect represented by 22,45mm^2. The mediane was 19,94$mm^2$to 10,30mm^2.

Comparing the central tendencies measure related to the various days collect the obtained results are in Table 2. Every average was compared using the Friedman Test which demonstrates a statistically significant difference in the general results obtained from the whole group ($p<0,001$). Comparing the Collect 1 to the Collects number 2, 5, 7 and 8 separately, there was respectively, central tendencies measure statistically different in both observed moments. And the comparison between collect 1 and collects number 3 and 4 separately, do not present statistically significant difference between both observed moments. We can notice in Table3 that stratifying the proportion of wound healing through test t, through gender, race and age, there were not statistically significant difference between groups 1 and 2 of any variable.

DISCUSSION

For the diabetic patient, the feet are the cornerstone, the body security and essential to move. So, the walking social representation is based in an Independence and autonomy relation. When patients were questioned about which body part worried them more thinking about Diabetes melitus, all of them mentioned the feet. Due to this, the worry is about the perception of the risk of developing the diabetic foot and its consequences. And this worry increases when patients identify alterations and discomfort in their feet. As a consequence, these people classify their feet as sick or healthy following its paradigms according to its representation (Coelho *et al*., 2009). Taking care is a basic action of every human being survivel. The way each individual takes care of his or her health is not universal, because it is related to life conditions and possibilities to keep the well being, creating many care ways, from scientific knowledge interpretation up to health popular practices. According to this life condition, the diabetes melitus was represented as an ignition to this care. Because being aware of this care is essential as the the perception that the person needs a habit change and reordering his or her routine (Coelho *et al*., 2009). The inflammatory reaction is a dynamic process that starts right after a sublethal lesion of any tissue and finishes with the complete healing of the lesioned part. The inflammatory process is compound by many inter-action parts (Minatel *et al*., 2009). The healing initial phase is called inflammatory and it is essential for the repairing process. Without inflammation, there is no repairing. There is an increase of capillary permeability and as a consequence cell migration (leukocytes, lymphocytes, eritrocytes) to the wound, that constitute the inflammatory exudate with the plasma accumulation (Minatel, 2009). The following is the proliferative phase or of fibroplasia. The endothelial proliferation, an essential process in the healing, dependson the presence of macrophages, which promote the neoangiogenesis due to its interactions with prostaglandins and tromboxanes. Near the broken capillary, the endothelial buds start which grow fastly, creating solid cords, interweaving with the fibroblastos, which form a channel allowing the blood flow. The recente formed connective, completely vascularized, constitutes the granulation tissue. And finally, the remodelling phase, which is related to the production and degradation of the diferent types of collagen, besides having an increase of the skin resistance which was the wound home (Minatel *et al*., 2009). It is known that the healing is a complex and dynamic process of reestablishment of epithelial tissue layers and cell structures, in a lesioned area, the most similar to its normal state.

Table 1. Evolution of the measure (in mm^2) of the wounds according to the moment of the collect

	COLLECT 1	COLLECT 2	COLLECT 3	COLLECT 4	COLLECT 5	COLLECT 6	COLLECT 7	COLLECT 8
N	30	30	28	28	28	27	23	21
Average	32,89	26,57	26,93	26,58	23,97	22,02	21,73	22,45
Mediane	19,94	14,93	15,55	14,90	10,70	10,80	8,10	10,30
Standarddesviation	39,53	36,41	33,68	30,80	31,03	26,73	30,19	31,57
Minimum	0,73	0,39	0,44	0,18	0,01	0,17	0,11	0,00
Maximum	195,70	182,70	159,80	144,20	124,30	117,30	124,30	130,10

Table 2. Comparison of the central tendency measure of all collect together in relation to collect 1.

	COMPARISON						
	Average		Mediane		Standard desviation		P
ALL COLLECTS*							<0,001
COLLECT 1 X COLLECT 2**	32,89	26,57	19,94	14,93	39,53	36,41	0,04
COLLECT 1 X COLLECT 3***	32,89	26,93	19,94	15,55	39,53	33,68	0,052
COLLECT 1 X COLLECT 4***	32,89	26,58	19,94	14,90	39,53	30,80	0,068
COLLECT 1 X COLLECT 5***	32,89	23,97	19,94	10,70	39,53	31,03	0,033
COLLECT 1 X COLLECT 6***	32,89	22,02	19,94	10,80	39,53	26,73	0,007
COLLECT 1 X COLLECT 7***	32,89	21,73	19,94	8,10	39,53	30,19	0,010
COLLECT 1X COLLECT 8**	32,89	22,45	19,94	10,30	39,53	31,57	0,002

*FRIEDMAN Test; ** WILCOXON Test; ***Paired Test t

Table 3. Comparison of the wound healing proportion by gender, race and age, respectively

	COMPARISON – Wound retraction percentage		
	1	2	p
Gender	38,17%	43,83%	0,789
Race	44,40%	34,90%	0,646
Age range	25,34%	45,85%	0,476

Subtitle: Gender: Group 1 (Men) e Group 2 (Women)
Race: Group 1 (White) e Group 2 (Non-White)
Age range: Group 1 (18 to 50 years old) e Group 2 (51 to 80 years old)

Thus, the lesion contraction is a process that happens all over the healing process, starting in the fibroblastic phase. In the maturation phase, the final phase of the healing process, the lesion is still suffering contraction, which leads to a lower quantity of showing cicatricial tissue. The granulation tissue formed in the final part of the proliferative phaseis firstly compound by fibroblasts, collagen, edema and the small and new blood vessels. In relation to the healing process phases it is known that in diabetes every sequence is committed which leads to a delay in the maturation/remodelling phases (Minatel *et al*., 2009). As observed in studies, the diabetes mellitus a multifactorial and chronic disease that can lead to various complications if it is not properly treated, as if macro and microangiopathy and/or neuropathy, reaching many organs like kidney, retina, heart and skin. Thus, these complications toegther with the comorbidities as chronic vein insufficiency and systemic arterial hypertension, increase the chance of having leg ulcers. Besides that, the diabetic patients are more susceptible to traumas, infections and, as a consequence, to ulcers, which have a slow treatment and, most of times, with a limited result, what decreases the life quality of these patients because it can lead to amputation and death (Minatel, 2009). The ulcer cicatrization is a complex biological sequence which involves cellular and molecular processes, as if inflammation, tissue formation (angiogenesis, fibro genesis e reepithelialization) and tissue remodelling. As a consequence, the clinical tissue characteristics of the ulcers show in which phase of the cicatricial process they are, like necrotic or yellow (esfacelo) tissue through initial inflammatory phase. Then, a red granulating tissue is formed (angiogenesis), which evolutes to a darker/winetissue, compact and of a non granulating aspect (fibroplasia).

Finally, the surface of the ulcer dicreases, specially by the reepithelialization of its edges. Therefore, these tissues show how dynamic the ulcer cicatrization is, and it can be documented by fotos and/or wound measures, showinh the progress ou not of the cicatrization as time goes by (Minatel *et al*., 2009). Brazil is a continental country, with different ecosystem, what enables the development of big number of vegetables that can be explored to evaluate its phytotherapy properties. As a consequence, it is a possibility to develop new drugs based in plants, which could be inserted in the therapeutic arsenal already existent. The phytotherapy is being much used in some countries in relation to synthetic drugs, due to cultural or financial factors. It has lower costs, no royalties, and most of plant based products are not patentable. In Africa, for example, the phytotherapy represents up to 80% of the medicine used by the population. However, there are risks in using phytotherapy, because there may be adverse reactions to the plants compounds. Phytotherapics may be known as natural and risk-free by popular culture. Therefore, the use of medicinal plants and phytotherapics to restore health is a common practice among many ethnic groups worldwide and is a cumulative result of hundreds years of empirical knowledge about the action of plants (Atzingen, 2011). With the increasing use of plant based products, not only the government but also health agents are paying more attention to this area. As a consequence, a big number of studies about the properties and use of fruits and its pulp and skin were made in India and China to determine its nutritional and medicinal facts. Studies about the banana properties, especially its pulp, showed it is rich in flavonoids and leucocyanidin, which are known by having antiinflammatory properties and being liver protector.

In its skin it has presented a powerful antihypertensive activity in renal hypertensive mice. As there are studies in literature relating the use of banana skin and leaves to improve epithelialization and relieves the pain in the treatment of chronic wounds (Atzingen, 2011). Research indicates that the banana skin has also a high quantity of phenols, measured by the method of kidnapping of the stable free radical 2,2-diphenyl-1-picrilhidrazil (DPPH) and of total phenols, which has proved the kidnapping of free radicals activity potential, showing again that the banana skin is effective in fighting against diseases related to free radicals (Baskar, 2011). There are reports in literature of a big number of authors who has worked with many phytotherapics aiming at influencing the scarring process, with different results. Sanchez *et al*. There are studies of the morphological and morpho metrical aspects of the tissue regeneration in skin wounds in mice with or without treatment with papa in solution in 2%. Its use has promoted a more effective tissue regeneration, acting in the initial phase and in wounds fibrous tissue. Researches also evaluated the influence of Asian *Centella* watery extract in wounds in albino mice. The results showed that the watery extract in suspension with propilenoglycol in 5% has favored the healing wounds process. There is another study of the morphological and morphometrical aspects of open skin wounds healing in mice, treated with copaiba oil. There was a delay in the process of having a wound in the group of copaiba in relation to the control group. It was also evaluated the use of arnica dye in open skin wounds in mice. The obtained results showed a delay in the wound healing retraction of the group arnica, in relation to the control group (Sanchez Neto *et al*., 1993; Brito, 1996; Miranda, 2001). There is a big number of papers with the use of *Musa sapientum* banana, by its leaf or its skin through extract or gel in different concentrations. The studies presented promising results in relation to its healing power. Although, it has been missed more studies in humans and there is none related to the use of this in diabetic pacients, the ones with the slowest healing process according to the literature. Studies have shown the healing effect of the *M. sapientum* extract in induced gastric ulcers in mice and in mice wounds (Goel *et al*., 2003; Mohan, 2006; Agarwal, 2009). A study said that using a 10% gel, produced from banana skin extract, in incisional wounds in mice, healing action of the *M. sapientum*. Besides that, he has verified its antimicrobial effect, as the enteric bacteria and pyogenic bacteria increasing inhibition. This study has also identified, through a phytochemical screening, tanninin the extract of green banana skin, important antioxidant effects, suggesting that the banana skin extract could be essential to fight against diseases caused by free radicals (Lino, 2011). Two estudies showed that the use of green banana skin4% gel in surgery wounds in micehas resulted in an increase of polymorphonuclear cells in the first week of testing, and after wards a decrease in the lesion area, decrease of vascular proliferation and increase of collagen fibers concentration on the third week of study, besides promoting a bigger area of epithelization (Atzingen, 2011; Atzingen, 2013). Through a study were made skin graft in 30 patients. The donor area was divided in 2 parts. One was covered with banana tree leaves and the other with vaseline gauze. The treatment with the banana tree was less painful, and its healing took less time, showing as a therapeutic action the healing effect of the banana tree in donor areas (Gore, 2003). Another important topic in this study is the fact that there were not significant diferences in the healing percentage among the present groups in relation to gender (Men and Women), race (White and Non White) and age (Between 18 and 50 years old and Between 51 and 80 years old) highlighting that the gel is effective no matter these diferences. The use of green banana skin gel in second intention wound healing in humans is not well documented in literature. As a consequence, the high economical and social costs for the government and for the patients related to the wounds treatment associated to an improvement of life quality from patients with these lesions are an important reason to search for new therapeutic alternatives. Therefore, if the green banana skin gel efficacy is confirmed, it will be an important for the development of new therapeutic possibilities related to this pathology.

Conclusion

The green banana skin gel in 10% has a healing in diabetic ulcers.

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