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Therapeutic ultrasound associated with essential oils of copaiba and tea tree for healing skin lesions

Ultrassom terapêutico associado a óleos essenciais de copaíba e melaleuca na cicatrização de lesões de pele

Ultrasonido terapéutico asociado con los aceites esenciales de copaíba y Melaleuca para curar lesiones cutáneas

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ABSTRACT

Objective: to evaluate the effectiveness of low-frequency ultrasound associated with copaiba and tea tree oil gel in healing skin lesions. **Method:** quasi-experimental study with pre and post-tests in a single group, carried out in a public hospital in Ceará, Brazil, from March to September 2017, with 14 participants who received 10 treatment sessions. **Results:** there was an average reduction of more than 20 cm² from the 1st to the 5th application. The reduction in the initial size for the 10th session was over 50%. There was statistical significance (p = 0.0043) between the initial evaluation and the 10th therapy evaluation, with an average reduction of 37 cm². There was a reduction in the intensity of pain reported by the participants and 62.5% were free of pain after applying the therapy. **Conclusion:** the use of the gel with copaiba and tea tree oil points to an alternative coverage associated with biostimulators such as ultrasound. The composition of the gel oil helped in the application and in the reduction of the maceration of the edge of the wounds, as well as the control of the exudate of the lesion.

DESCRIPTORS: Healing; Ultrasound therapy; Volatile oils. Stomatherapy.

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RESUMO

Objetivo: avaliar a eficácia do ultrassom de baixa frequência associado ao gel de óleos de copaíba e melaleuca na cicatrização de lesões de pele. **Método:** estudo quase-experimental com pré e pós-testes em grupo único, realizado em hospital público no Ceará, Brasil, no período de março a setembro de 2017, com 14 participantes que receberam 10 sessões de tratamento. **Resultados:** houve redução média de mais de 20 cm^2 da 1ª para 5ª aplicação. A redução no tamanho inicial para a 10ª sessão foi superior a 50%. Houve significância estatística (p=0,0043) entre a avaliação inicial e a 10ª avaliação da terapia, com redução média de 37 cm^2. Houve redução na intensidade da dor relatada pelos participantes e 62,5% estavam livres da dor após aplicação da terapia. **Conclusão:** o uso do gel com óleo de copaíba e melaleuca aponta para uma alternativa de cobertura associada a bioestimuladores como o ultrassom. A composição do óleo em gel auxiliou na aplicação e na redução de maceração do bordo das feridas bem como o controle do exsudato da lesão.

DESCRITORES: Cicatrização; Terapia por ultrassom; Óleos voláteis. Estomaterapia.

RESUMEN

Objetivo: Evaluar la efectividad de la ecografía de baja frecuencia asociada con la copaiba y el gel de aceite de árbol de té en la curación de lesiones cutáneas. **Método:** Estudio cuasiexperimental con pre y pospruebas en un solo grupo, realizado en un hospital público de Ceará, Brasil, de marzo a septiembre de 2017, con 14 participantes que recibieron 10 sesiones de tratamiento. **Resultados:** Hubo una reducción promedio de más de 20 cm2 de la primera a la quinta aplicación. La reducción del tamaño inicial para la décima sesión fue superior al 50%. Hubo significación estadística (p=0,0043) entre la evaluación inicial y la décima evaluación de la terapia, con una reducción promedio de 37 cm^2. Hubo una reducción en la intensidad del dolor informada por los participantes y el 62,5% no sintió dolor después de aplicar la terapia. **Conclusión:** El uso del gel con copaiba y aceite de árbol de té apunta a una cobertura alternativa asociada a los bioestimuladores, como la ecografía. La composición del aceite en gel ayudó en la aplicación y en la reducción de la maceración del borde de las heridas, así como en el control del exudado de la lesión.

DESCRIPTORES: Cicatrización de heridas; Terapia de ultrasonido; Aceites volátiles.

INTRODUCTION

The use of physical therapy resources can trigger positive effects in the healing process of skin lesions, which accelerate the different stages of tissue repair and reduce the time of injury through the application of electrophysical resources[1]. Among the physical therapy resources used to accelerate the tissue repair process is low-frequency ultrasound (LFUS). Ultrasound waves have recently been developed to treat different wounds that are difficult to heal, with promising therapeutic results[2].

LFUS is characterized as a mechanical wave in which its vibrational energy is broken down into molecular energy, which permeates multiple therapeutic effects, such as increased vascularization and collagen synthesis, in addition to minimizing the inflammatory process, which drives tissue repair[3].

The advances achieved in the area of wound care have also appropriated knowledge and popular culture, such as essential oils (EOs). EOs are secondary metabolites extracted from various parts of plants, which have terpene hydrocarbons, with a predominance of monoterpenes, alcohols and sesquiterpenes, which have bactericidal characteristics that help healing[4,5].

Copaíba (*Copaifera sp.*) and tea tree (*Melaleuca alternifólia*) have shown their effectiveness in the treatment of wounds and in the healing process because they contain antibacterial, anti-inflammatory, antiviral, antifungal and analgesic activity[6,7].

The literature shows success in the association of topical coverings and LFUS for the treatment of skin lesions. The LFUS provides phonophoresis and, thus, the substances found on the lesion are helped by the waves generated to penetrate the skin layers more easily, accelerating its absorption and its effects on the lesion[8].

The study becomes relevant because it seeks to identify the effects of physical therapy used in the treatment of wounds in association with EOs of copaiba and tea tree in gel form, based on the regeneration of the injured tissue that may contribute to the improvement in the quality of life of people with skin lesions and minimize the risk of non-traumatic lower limb amputations.

The objective of the study is to evaluate the effectiveness of LFUS associated with the gel with copaiba and tea tree oils in the healing of skin lesions.

METHOD

Study design

Quasi-experimental study with a single pre- and post-test group, carried out in a tertiary hospital in the state of Ceará, Brazil, from March to September 2017.

Selection of participants

Participants were recruited from a stoma therapy outpatient clinic and medical and surgical inpatient clinics at the hospital. The study included individuals over 18 years of age; who had lesions with loss of epidermis, dermis and/or subcutaneous tissue requiring follow-up or chronic injuries; and be accompanied at the hospital, in the inpatient or outpatient sector.

Patients unable to attend the hospital were excluded; presentation of three or more factors that impair healing: diabetes mellitus, smoking, autoimmune disease, use of corticosteroids, devitalized tissue with necrosis, indication of limb amputation or hypersensitivity in the wound. The exclusion of patients with three or more factors that impair healing is due to the fact that this could generate bias in the effectiveness of LFUS therapy, since these patients would already tend to a longer healing process.

Of the 35 participants recruited, 14 were available to complete the intervention (minimum 10 sessions with ultrasonic therapy associated with the gel with copaiba and tea tree oil), which comprised the research sample.

Data collect

Data collection was carried out through the application of a form, structured in three parts: 1) questions related to the sociodemographic profile (age, sex, education, basic sanitation); 2) questions related to the clinical aspects of the participants (arterial hypertension, type 2 diabetes mellitus and days following the wound); 3) lesion identification data (skin type, treatment used, type of ulceration, appearance, displacement and aspects of the wound edge).

To measure the lesions, the Pressure Ulcer Scale for Healing (PUSH) was used, which compiles data related to the lesion area, tissue type and amount of exudate, generating a score value that can be inserted in a graph and follow the evolution of wound healing.

Pain was assessed before, during and shortly after the intervention, using the Visual Analogue Scale (VAS), in each treatment session. Pain was also measured by means of a pain survey, being classified into: 1 - acute non-cyclical pain; 2 - acute cyclic pain; 3 - chronic pain; and 4 - no pain. Acute cyclic pain was considered as intermittent pain that ceases and starts again during periods of the day for less than six months; acute non-cyclical pain such as pain that does not cease in less than six months; and chronic pain as pain for more than six months. The use of ultrasound was recorded as to the day of application, code for the lesion and time of application.

Intervention process

The ultrasound used was the Sonopulse III Ibramed - 1 Mhz and 3 Mhz, with 21W of power and 3.5cm diameter of the effective irradiation area (ERA). The application of LFUS in injuries was performed by three nurses.

First, the lesion was cleaned with 0.9% saline. Then, the gel with copaiba and tea tree oils was applied to the wound bed, respecting the edges of the lesion, with a layer of approximately 0.3mm, followed by the application of polyvinyl chloride (PVC) film around the lesion to maintain the safety margin of the edges. Soon after, the ultrasound transducer was wrapped with PVC and an acoustic impedance agent was applied in the form of a water-based gel.

After that first moment, there was the application of the transducer starting at the edges of the lesion with extension to the center of the wound, with a margin of 1 cm between the application areas. Lesions were measured with a tape measure in square centimeters in the first, fifth and tenth ultrasound applications.

The participants were followed up on alternate days and the ultrasound technique followed standardization of variance according to the size and characteristic of the lesion, in pulsed mode, energy density of 3W/cm^2 and frequency of 1 MHz. The ultrasound was applied in movements in the form of eight, gently, counterclockwise[2].

The estimated application time was determined by calculating the length multiplied by the width of the lesion and divided by the ERA. After each individual calculation, the application time, measured in minutes, was placed on the device. At the end of the calculated time, the LFUS would trigger the alarm to signal the end of the intervention.

Data analysis

The collected data were tabulated in the Excel 2016 program and analyzed in the Statistical Package for the Social Sciences (SPSS), version 20 statistical program. Categorical data were presented in absolute and percentage frequency, and compared using Fisher's exact or Pearson's Chi-square tests.. The Kolmogorov-Smirnov normality test was performed on the quantitative data, which were expressed as mean and standard error of the mean, with analysis using the Friedman test, then Dunn's post-test and Spearman correlation. Student's T-test was used to compare the means of the lesion areas. The level of significance was set at 5%.

Ethical aspects

This research received approval from the Research Ethics Committee (CEP) of Universidade Internacional da Integração da Lusofonia Afro-Brasileira, through opinion no. 1,049,373/2015. All consignments of Resolution No. 466/12 of the National Health Council were followed and all participants signed the Free and Informed Consent Form.

RESULTS

There were 14 patients, who added 17 injuries. The main characteristics of the participants were the predominance of males (71.4%), with an average age of 59.9 years (± 18.7), retirees (54.1%) and farmers (28.5%), self-reported as brown (85.7%) and illiterate (71.4%). The diagnosis of type 2 diabetes mellitus was present in 5 participants, who underwent treatment of the disease (35.7%). Among hypertensive patients (n = 5), only one underwent drug treatment for the disease. Only one participant claimed to be alcoholic.

Table 1 presents information regarding the injuries and the skin of the participants who underwent LFUS. There was a predominance of very thin (29.4%) and discolored (23.5%) skin. Regarding the type of wound, diabetic foot (35.3%) and pressure injuries (29.4%) were prevalent, with an edge that presented erythema (47.1%). In the lesion bed, slough was present in most lesions in the initial evaluation (58.8%). Pain (acute cyclic and non-cyclic) was also present in most injuries.

Table 1. Distribution of lesion and skin characteristics of patients using low-frequency ultrasonic irradiation associated with copaiba and tea tree gel. Acarape (CE). Brasil – 2017.

Skin type - start of application	n (%)
Very thin	05 (29.4)
Dry	03 (17.6)
Bleached	04 (23.5)
Moist	02 (11.8)
With edema	03 (17.6)
Wound type	**n (%)**
Venous ulcer	02 (11.8)
Arterial ulcer	01 (5.9)
Pressure injury	05 (29.4)
Diabetic foot	06 (35.3)
Traumatic	02 (11.8)
Other	01 (5.9)
Appearance	**n (%)**
With necrosis	04 (23.5)
With infection	03 (17.6)
With slap	10 (58.8)
Topical treatment used	**n (%)**
None	01 (5.9)
Papain	02 (11.8)
Alginate	03 (17.6)
Essential Fatty Acids	06 (35.3)
Collagenase	04 (23.5)
Others	01 (5.9)
Pain	**n (%)**
No	05 (29.4)
Acute non-cyclical pain	05 (29.4)
Acute cyclic pain	05 (29.4)
Chronic pain	02 (11.8)
Edge displacement	**n (%)**
No	14 (82.4)
Yes	03 (17.6)
Edge	**n (%)**
Erythema and heat	08 (47.1)
Hardened edge	03 (17.6)
Disruption	03 (17.6)
Peeling. dry skin around the wound	03 (17.6)

The evaluation of the applications through the average of the lesion area revealed an average reduction greater than 20 cm^2, from the 1st to the 5th application. The reduction in the initial size up to the 10th session was greater than 50%. In the evaluation, there were injuries that showed healing in the 10th session (n = 2). The variation of the lesion areas is highlighted, where minimum and maximum values were distant (Table 2).

Table 2. Distribution of low frequency ultrasound applications and the average lesion area assessed before the initial application, after five applications and ten applications. Acarape (CE), Brasil – 2017.

Number of ultrasound applications	N	Average area (cm²)	Standard deviation ±	Min	Max
0 aplicações	17	64.18	79.66	5	270
5 Aplicações	17	43.65	53.99	4	182
10 Aplicações	17	27.18	42.87	0	156

Table 3 shows differences between the averages of the areas of the lesions in the three moments of evaluation. There was greater statistical significance (p = 0.0043) between the initial evaluation and the tenth application of the LFUS associated with the copaiba and tea tree gel, with an average reduction of 37 cm².

Table 3. Difference of means for two paired samples between the periods of application of the low-frequency ultrasound associated with the gel with copaiba and tea tree. Acarape (CE), Brasil – 2017.

Number of ultrasound applications	N	Medium (cm²)	Standard Error	T	P
0 aplicações	17	64.176	19.320		
5 aplicações	17	43.647	13.095	2.899	0,011
Diferença		20.529**	23.340		
0 aplicações	17	64.176	19.320		
10 aplicações	17	27.176	10.397	3.323	0,0043
Diferença	17	37.000***	11.135		
5 aplicações	17	43.647	13.095		
10 aplicações	17	27.176	10.397	3.069	0,007
Diferença	17	16.471***	5.367		

T = Student's T test; P = P-value; **Significant at 5%; ***Significant at 1%.

Figure 1 shows the distribution of means, with a statistical difference in the reduction of the area between the initial mean and the 5th application, and between the mean in the 5th evaluation for the 10th application of LFUS associated with the gel with copaíba and tea tree (p<0.005).

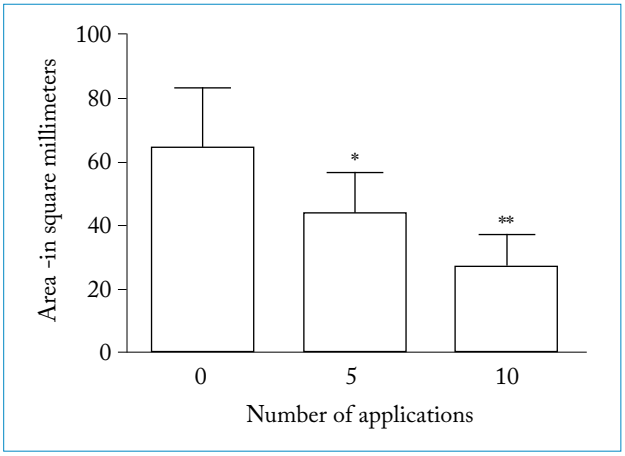

Figure 1. Distribution of means between the initial mean, fifth application and tenth application of low-frequency ultrasound associated with the copaiba and tea tree gel. Acarape (CE), Brasil – 2017.
*p<0.05 versus 0 applications; **p <0.05 versus 5 applications, Friedman / Dunn test (mean ± SEM).

Figure 2 shows the logistic regression to identify the time for healing of the lesion with the application of LFUS associated with the gel with copaiba and tea tree. The regression model between the number of applications and the average lesion size was used. The need for 17 applications was identified to estimate an average lesion area of 0 cm² (p = 0.026, r = -0.311, r^2 = 0.061). In the Spearman correlation, p <0.05 was identified.

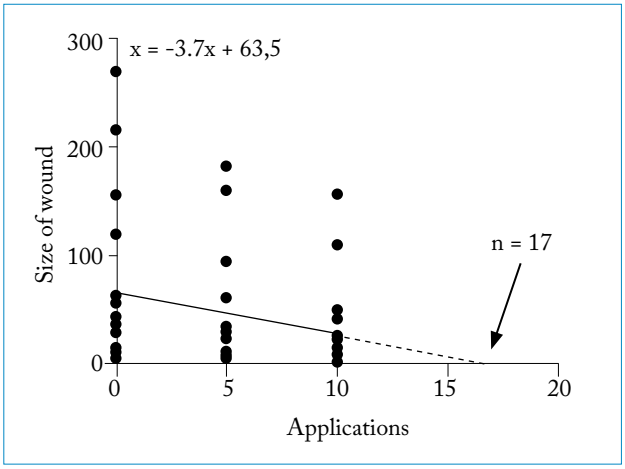

Figure 2. Logistic regression of the number of applications and the average of injuries. Acarape (CE), Brasil – 2017.

Table 4 shows the intensity of pain reported by patients at four levels: intense, moderate, mild and without pain. Being evaluated in three time cuts: before, during and after the application of ultrasound therapy. There was a reduction in the pain intensity reported by the patients and 62.5% were free of pain after the application of the therapy.

In Fig. 3, the evaluation of PUSH reveals a reduction in the area in all lesions evaluated.

Four injuries did not show a reduction in the score between the 5th and 10th application of the LFUS (injuries 06, 08, 10 and 17). Two lesions showed complete healing (Fig. 3).

Table 4. Distribution of pain assessment before. during and after applications of low-frequency ultrasound associated with copaiba and tea tree gel. Acarape (CE). Brasil – 2017.

Pain	Before	During	After	*p**
Intense	5 (31.3%)	2 (12.5%)	1 (6.3%)	0.227
Moderate	4 (25.0%)	4 (25.0%)	3 (18.8%)	
Mild	4 (25.0%)	2 (12.5%)	2 (12.5%)	
No Pain	3 (18.8%)	8 (50.0%)	10 (62.5%)	

* Pearson's chi-square test.

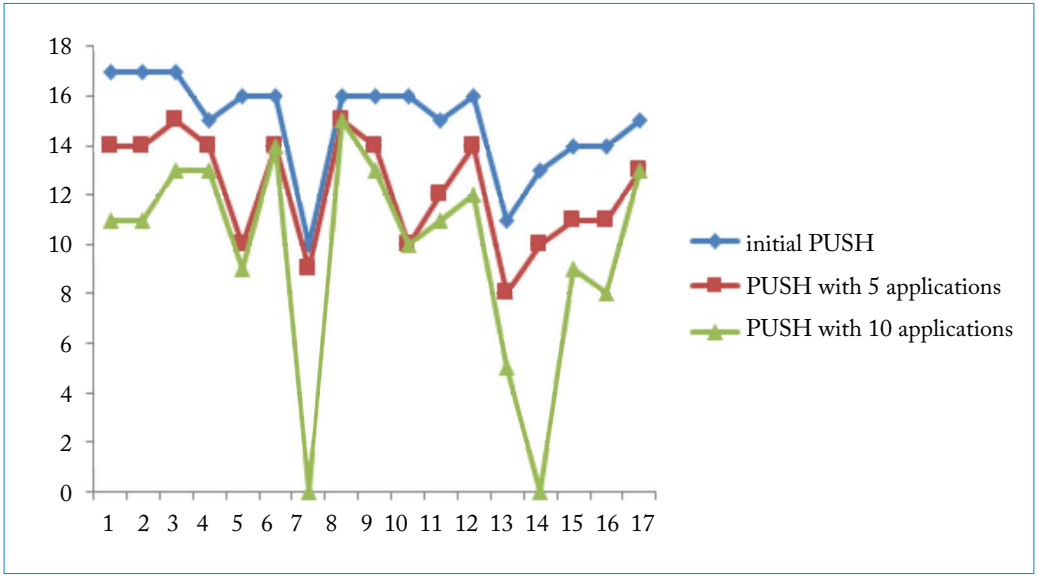

Figure 3. Distribution of the Pressure Ulcer Scale for Healing score in the initial evaluation, after five and ten applications. Acarape (CE), Brasil – 2017.

DISCUSSION

The characteristics of the lesions and their type agreed to identify factors that can hinder the healing of wounds, mainly related to the type of skin and edge of the lesion.

Regarding the classification of wounds, most are characterized as diabetic feet followed by pressure injuries. Differing finding from the epidemiological panorama of the study region, in which venous ulcers and pressure injuries are predominant[9,10]. Such chronic lesions present difficulties in healing and require that new adjuvant therapies be used in combination with conventional treatment. Research with adjuvant therapies such as LFUS is steadily advancing and its effects have been described over time and in clinical practice[11].

Consulted study, which associated LFUS with vitamins in cutaneous lesions, identified that the treatment was more effective in the first phase of the healing process, with greater maturation of collagen fibers[8].

Low-frequency waves can accelerate the healing speed of open wounds as well as deep tissue injuries[2].

Thus, the possibility of stimulation in deep tissues points to LFUS as a tool that accelerates the healing process and prevents new injuries, however, research still does not show a specific protocol for the treatment of different injuries[12].

Thus, the number of applications of ultrasonic therapy established in the study was ten applications, as it is noticeable that the use of low intensity radiation loses effectiveness according to the number of subsecutive sessions[13].

The disparity of applications and parameters used can culminate in the empirical use of LFUS by some professionals, generating divergence in the results found in different researches[14].

In this study, the gel with copaiba and tea tree EOs was used in association with ultrasonic therapy. In other studies[15,16], copaiba oil showed positive transmissibility for use by LFUS phonophoresis, antimicrobial activity, which stopped the purulent exudation in the area of the lesion and also contributed to the multiplication and advancement of granulation tissue, and tea tree oil inhibited growth of fungi and bacteria[17].

The analysis of the distribution of the lesion means revealed a statistical difference in the reduction of the area between the initial average and the 5th application, and between the average in the 5th evaluation for the 10th application of the LFUS ($p<0.005$). This finding is relevant because it indicates a beneficial action in the progress of the healing of lesions of various etiologies.

Studies in Europe have identified, respectively, greater mean reduction of the wound area in the LFUS treatment group (67.0%), in addition to decreasing the patient's exudate and pain, dispersing biofilms and increasing healing in wounds of various etiologies[18,19]. The LFUS principle also activates fibroblasts in soft tissues, which helps in the progress of tissue regeneration and protein synthesis through a cavitation and micro-flow process[20].

The reduction observed in the area of injuries, even in individuals with underlying diseases, such as hypertension and diabetes that hinder vascular circulation and consequently oxygenation, can be justified by the fact that low frequency ultrasonic therapy increases metabolism, cell proliferation and local oxygenation. In an Asian study, results showed that the application of LFUS in wounds caused by diabetes promotes the expression of endothelial growth factor, transforming growth factor, inhibits the expression of interleukin and tumor necrosis factor[21].

LFUS presents positive aspects to the healing process, from the reduction of the lesion area to the increase of viable tissue, which stimulates faster healing compared to conventional dressing techniques, with a more resistant scar tissue[11].

In addition, in this study, patients reported improvement in pain during and after LFUS application, thus reaffirming the analgesic effect of ultrasonic therapy, which corroborates another consulted study, in which all patients showed significant pain reduction after treatment with LFUS[19]. This is an important fact, since pain is one of the most common symptoms reported by individuals with wounds. Pain affects both the lesion area and adjacent areas, and can affect even the entire limb[22].

It is noteworthy that the LFUS has, so far, no reports of adverse events generated as a result of its application. Thus, it has therapeutic applicability for analgesia, being a source of pain relief to be considered in the hospital/outpatient setting.

LFUS is an adjuvant resource that can be used in wound healing. This technology has been used for some years in the care of wounds, mainly by physiotherapy professionals, however nursing has been appropriating the use of this resource, which implies the need for new publications in the field of nursing so that there is greater understanding and use of this adjuvant technology in the treatment of skin lesions.

The association of LFUS with other healing agents in the wound bed should be further investigated to enhance and disseminate its effects. The time of application of the ultrasound was a limiting factor, considering injuries with large areas for application, which may limit its use in the hospital and/or outpatient routine.

CONCLUSION

The use of the gel with copaiba and tea tree oil points to an alternative coverage associated with biostimulators such as LFUS, due to the effect of phonophoresis. The composition of the gel oil helped in the application

and in the reduction of the maceration of the edge of the wounds, as well as the control of the exudate of the lesion. The intervention with LFUS associated with the gel with copaiba and tea tree oil was carried out without complications and presented itself as a therapeutic resource for the reduction of the wound area as well as its healing.

AUTHOR'S CONTRIBUTION

Conceptualization: Mororó DGA; Brandão MGSA and Ponte VA; Research: Mororó DGA; VA bridge; Silva ASJ and Batista FWS; Writing - First version: Mororó DGA; Brandão MGSA; VA bridge; Veras VS and Araújo TM; Writing - Review & Editing: Brandão MGSA and Araújo TM.

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