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MUCCOPOLYSACCHARIDE POLYSULPHATE AND HUMAN SKIN HYDRATION AND ELASTICITY

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ABSTRACT

A more than 50-year history of use in medicine has been MPS, a mucopolysaccharide polysulphate. It is used to treat inflammation and thrombosis. Hydrogen bonds between its molecules and adjacent water molecules allow it to effectively hydrate surrounding tissues. Furthermore, it increases the skin's viscoelasticity and water-binding capacity by stimulating endogenous hyaluronate synthesis. Studying the effectiveness of 0.1% MPS in hydration and elasticity of human skin. In the first part of this study, 120 female volunteers with dry skin, as defined by Corneometer, aged 31–50 years were randomized double-blind placebo-controlled. MPS 0.1% or a vehicle control were administered to the volunteers. For a period of four weeks, each subject applied 1 g of cream twice daily to their face. We recruited 40 female volunteers between the ages of 31 and 50 who had dry skin according to Corneometer. Identical forearms were randomly selected for the application of MPS cream containing 0.1%. Skin hydration measurements were taken at baseline, immediately after application, and every 1 hour thereafter. This improvement was maintained for 10 hours. Comparing MPS with vehicle control, women with dry skin experienced an improvement in skin hydration but not in skin elasticity. After a single application of MPS, skin hydration remained improved for at least 10 hours.

Key words: Muccopolysaccharide, Polysulphate, Skin, Hydration.

INTRODUCTION

As skin ages, collagen in the dermis is lost, elastic fibers degenerate, and the epidermis loses its hydration [1]. As we age, dry skin becomes more severe. Furthermore, xerosis has been linked to changes in epidermal basal and differentiation-related keratins, as well as premature expression of an envelope protein called involucrin, similar to those observed in dry skin [2]. For over 50 years, mucopolysaccharide polysulphate (MPS), an organoheparinoid compound naturally occurring in nature, has been used in medicine as an antithrombotic and antiinflammatory agent for treating osteoarthritis, thrombophlebitis, and thromboembolism prevention [3–11]. As a result of topical administration of MPS, therapeutic systemic effects have been achieved, including the prevention and treatment of local symptoms associated with peripheral vascular disorders [4].

Polysaccharides containing repeating disaccharides make up MPSs structurally. Water molecules have considerable hydrogen bonds with the chemical structure, which results in effective hydration of the surrounding tissue through its ability to retain water [12–14]. MPS may also be able to enhance hydration by increasing hyaluronate synthesis, giving the skin an increased ability to bind water and increase viscoelasticity [14]. RNA levels of glycosaminoglycans and proteoglycans in the extracellular matrix can be increased with MPS. MPS inhibits skin-degrading enzymes, such as elastase and hyaluronidase [7]. Human skin hydration and elasticity were evaluated quantitatively using MPS 0.1%.

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MATERIAL AND METHODS

A 0.1% MPS-containing cream was applied to the skin for two weeks to determine if it had a measurable clinical effect on skin hydration and/or elasticity. This study was divided into 2 parts. In the first part, 0.1% MPS was studied for its efficacy on human skin hydration and elasticity. For this part of the study, 120 females aged 31 to 50 were recruited. This study recruits participants from individuals who respond to an announcement posted at the hospital affiliated with the university. The following criteria were used to select participants: non-dis-eased facial skin, as confirmed by the investigators; dry skin, as defined by a Corneometer reading of 60 or less; a "washout period" of one month in which no topical treatments or systemic treatments known to affect the skin were allowed; the following agreed to follow the study protocol in its entirety. The following criteria are excluded from the study: inability to provide informed consent; diseased facial skin; normal skin hydration as defined by the Corneometer CM825 reading of more than 60; and inability to comply with the study protocol or washout period. Participants were required to provide written informed consent. In the study, participants were randomized to two separate groups, for which they applied either 0.1% MPS that contained or a 0.1% MPS that was free of MPS for four weeks. Corneometer CM 825 and Cutometer MPA 580 were used at baseline and week 4 to measure skin hydration and elasticity.

The study drug treatment site prohibited the application of moisturizer, toner, foundation, concomitant medication, or any topical treatment of any kind during the four-week study period. Cleanser supplied with the kit was the only one permitted to be used. Approximately sixty grams of either MPS-containing or vehicle-control cream were given to each volunteer. Mineral oil glycerin, emulgator, purified water, and liquid paraffin made up the vehicle-control cream. Each type of topical treatment was packaged identically, so neither the volunteer nor the investigator could tell which type was being used. After facial cleansing, volunteers applied 2 grams of the study cream twice daily, avoiding the periorbital area, after applying the study cream 2 times daily overnight. Any cream that accidentally entered the eyes was to be rinsed with tap water.

Two blinded investigators measured forehead and cheek hydration and elasticity at baseline and immediately after the 4-week period. Based on a scale of 0 to 130, the hydration value was graded. A Cutometer probe was used to determine elasticity. There were 10 different values presented (R0–R9). Skin elasticity is measured by R5. Temperature and humidity were controlled at 25°C and 60% respectively in the temperature- and humidity-controlled room.

Secondly, this study aimed to evaluate whether 0.1% MPS was effective at hydrating the skin after a single application. Our study recruited 20 female volunteers aged 30–45 who had dry skin, as defined by corneometer CM 825, for a randomized double blind placebo-controlled trial. A total of 2 grams of 0.1% MPS cream was applied to entirely randomly selected fly forearms of all subjects. Skin hydration at the middle of both volar forearms was measured at baseline, immediately after application, and every 1 hour after application for a period of 10 hours. Temperature and humidity were controlled in the room, which was 25°C and 60% humidity. Research involving human subjects in this study was approved by the Faculty of Medicine's Ethical Committee.

RESULTS

The first part of the study involved 120 participants who completed the study protocol over a period of four weeks. The corneometer measured skin hydration values at baseline and after the 4-week study period, with both groups showing statistically significant improvements. Further, compared between the control group and study group, there was a statistically significant difference in hydration improvement ($P = 0.01$). In spite of statistically significant improvements in elasticity in both groups after the 4-week period on the Cutometer at reading, no statistically significant differences were observed ($P = 0.15$ between control and study groups). Both the control and study treatments were well tolerated by the volunteers. The protocol for the second part of the study was completed by all 20 subjects. During the study period of 10 hours, no significant differences were found among patients' ages, room temperatures, or air humidity. A baseline hydration value of 42 was recorded in MPS and 41 on the control side. The corneometer measured skin hydration values for the MPS and control sides before and after treatment ($P = 0.61$), and there was no significant difference in skin hydration between the two groups. The MPS side, however, showed significant improvements in skin hydration immediately following application, and these improvements lasted for 10 hours following the initial application ($P = 0.01$). During the study period, no adverse reactions were reported by the volunteers.

DISCUSSION

As with the body's mucopolysaccharides, MPS cream contains mucopolysaccharide polysulphate. MPS topically applied has demonstrated clinical effects that are in accordance with its pharmacological properties [15]. A significant difference in skin hydration was observed when MPS was applied twice daily for four weeks over a control cream base, compared to MPS application twice daily. Taking the hydroxyl groups of MPS, a glycosaminoglycans (GAG) derivative, into account may explain our findings. MPS readily forms hydrogen bonds with adjacent water molecules. As a result of the association of water with MPS molecules, skin surrounding the MPS molecules is less likely to become desiccated.

Skin hydration is associated with numerous skin conditions, including cutaneous photoaging and xerosis, and consistent MPS application improves skin hydration. When the dermis is sun-protected, GAGs are distributed diffusely throughout the dermis between collagen bundles, as opposed to concentrated deposits in the mid- and deep dermis during skin photoaging [7]. Due to the altered structure of elastotic materials in sun-damaged skin, glycosaminoglycans may not function as they do in sun-protected skin. GAGs may be distributed more evenly by MPS topical application than they are by healthy non-UV-damaged skin. GAGs that are evenly distributed may therefore promote hydration and assist in moving nutrients and metabolites throughout the body [16].

The condition of xerosis, characterized clinically by dry skin, cracked skin, fissures, and scaling, has become increasingly prevalent among the elderly as a result of a reduction in the activity of the sebaceous glands and sweat glands [16]. As a result of epidermal water loss, this condition is characterized by cracks and fissures. MPS may improve this condition.

In vitro studies examined MPS absorption by the dermis of humans. The results showed that MPS was capable of penetrating skin and reaching dermal layers in an effective concentration [17]. However, the absorption of MPS to the systemic circulation was too low to influence blood coagulation. This could be interpreted that MPS may be "trapped" in dermis leading to increased epider- mal water retention. Due to the inclusion of organoheparin, hyaluronic acid, glycosaminoglycans, and so on in MPS.

An increase in hyaluronic acid and glycosaminoglycan content could improve skin hydration [18, 19].

It was notable that elasticity improved significantly between the two groups after 4 weeks of application of either the cream base or the MPS-containing cream. Nevertheless, MPS application did not significantly improve skin elasticity when compared to control cream base, indicating that MPS does not have a significant physiological effect on skin that results in a significant increase in collagen production resulting in a clinically detectable improvement in skin elasticity. It is likely that other vehicle cream base ingredients, such as glycerin and liquid paraffin, improve skin elasticity in both groups [20, 21].

Second, we demonstrate that a single MPS application resulted in significant improvements in skin hydration for at least 10 consecutive hours, compared to similar application using a control cream base. Taking into account the chemical structure of MPS may explain why MPS may be beneficial in treating xerosis, according to the results of this study. Hydrogen bonds between adjacent water molecules are formed readily by MPS, a glycosaminoglycans (GAGs) derivative. By preventing evaporation of water, MPS molecules prevent skin from becoming desiccated.

CONCLUSIONS

Compared with the vehicle control, MPS improved skin hydration but did not increase skin elasticity in women with dry skin. Following a single application, MPS can also improve the hydration of human skin for at least 10 hours. Optimal MPS concentrations for treating xerotic skin conditions should be evaluated in future studies.

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