Journal of Clinical & Experimental Ophthalmology

Jain et al., J Clin Exp Ophthalmol 2017, 8:5
DOI: 10.4172/2155-9570.1000678

Short Communication Open Access

Brief Communication: Dexpanthenol and Its Ophthalmic Uses

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Received date: July 06, 2017; **Accepted date:** August 24, 2017; **Published date:** August 28, 2017

Introduction

Dexpanthenol is an alcoholic analog of pantothenic acid which was discovered by Roger J. Williams in 1933 [1]. Pantothenic acid, also called pantothenate or vitamin B5, is a water-soluble vitamin [2]. It is yellow, viscous, hygroscopic oil which is stable in neutral solutions but decomposes rapidly in acid or alkaline solution [2]. Therefore, it is sold as calcium and sodium salts. Animals require pantothenic acid to synthesize coenzyme-A, as well as to synthesize and metabolize proteins, carbohydrates, and fats [3]. It is essential to almost all forms of life.

Source

The name pantothenic acid is derived from the Greek word pantothen, which means "from everywhere" and small amount of it is present in almost every food (legumes, whole grain cereals, eggs, meat, avocado and curd) [4]. The most significant sources of pantothenic acid in nature are cold water fish ovaries and royal jelly [5].

Mechanism of action

Dexpanthenol was discovered almost 70 years ago but still its exact mechanism of action has not been made clear. It has hygroscopic properties and ability to retain moisture. The hydrating effect seems to be interrelated with its capacity to regenerate the epidermal barrier by enhancing epidermal differentiation and lipid synthesis [6].

In a study on excised porcine skin, dexpanthenol has been shown to interact with lipid segments of the extracellular lamellae and protein residues in the corneocytes of stratum cornea resulting in an increased mobility of molecular components. Thus it generates properties of a hydrated skin in dehydrated conditions by increasing molecular fluidity [7].

Various studies have shown that dexpanthenol contributes to wound healing by aiding collagen synthesis, proliferation, migration and attachment of fibroblasts [8,9]. However, molecular mechanism of dexpanthenol was not known until 2009, when Wiederholt et al. investigated *in vitro* molecular mechanisms of pantothenate on the proliferation of dermal fibroblasts. Gene expression was analyzed using microarray analysis in human dermal fibroblasts cultivated with 20 microgram/ml of pantothenate [10]. As compared to untreated cells, treated fibroblasts showed a significant upregulation of *IL-6*, *IL-8*, *Id1*, *HMOX-1*, *HspB7* and *CYP1B1* expression. As IL-6 and IL-8 are among the cytokines most strongly expressed during wound healing [11,12], the upregulation of IL-6 and IL-8 expression in dermal fibroblasts further supports the fact that dexpanthenol containing topical ointments contribute to the wound healing.

Pantothenic acid, pantothenol and its derivatives being precursors of CoA, protect cells and organs against peroxidative damage by increasing the content of cell glutathione. By increasing the synthesis of coenzyme A, mitochondrial coenzyme A is also increased which leads to more ATP synthesis. ATP and coenzyme A are indispensable for synthesis of phospholipids and cholesterol, which again have a role in repair of cell membranes [13].

Toxicity

No toxic effects after oral or parenteral use have been observed so far with pantothenic acid or any of its salts [14].

Uses

Pantothenic acid and Dexpanthenol can both be used topically, orally and parenterally. These drugs have a huge role in burns caused by heat radiation or chemical injury. They augment the healing of skin and mucus membrane lesion of almost any origin. It has been seen that cell cultures with a higher concentration of calcium D-pantothenate had increased migration of cells with a more directional arrangement in several layers, whereas the cell cultures without pantothenic acid healed in a haphazard manner with fewer layers [9].

Dexpanthenol, because of its soothing, anti-inflammatory, moisturizing properties and hygroscopic nature is used in lots of cosmetic products as emulsions, sunscreens, mouthwashes, shampoos and dental rinses [12,15].

Dexpanthenol ointment has shown promising result in healing of foot ulcers in diabetic patients. A study done by Abdelatif et al. indicated that royal jelly and panthenol ointment can help cure the ulceration [16].

Pantothenic acid derivatives have also been used to improve lipid profile. In a mouse model by Naruta et al. panthothenic acid derivatives were able to eectively lower low-density lipoprotein (LDL), as well as triglyceride (TG) levels; panthenol was able to lower total cholesterol, and pantethine was able to lower LDL-cholesterol in the serum [3]. The decrease in LDL is significant, as it is related to a decrease the risk of myocardial infarction and stroke [17].

Role of dexpanthenol in ophthalmology

Dexpanthenol plays an important role in healing of the conjunctival and corneal epithelial damage. Due to its hygroscopic nature, it prevents epithelial dryness and maintains the ocular surface integrity. Ocular surface protecting and healing properties of dexpanthenol have been proven in a study by Raczynska et al. using 5% provitamin B5

drops and gel for postoperative treatment of corneal and conjunctival injuries [18].

Another study conducted by Raczynska et al. used dexpanthenol for doing Goldmann triple-mirror examination and found significantly lesser congestion and better adherence to the corneal surface [19]. The dexpanthenol containing artificial tears (Siccaprotect) improved disturbances of the corneal epithelial permeability significantly in comparison to the dexpanthenol free eye drops [20].

So far the role of pantothenic acid has been limited only to the disorders of ocular surface. In our experience dexpanthenol ointment given in patients of corneal ulcer and chemical burns reduces patient's discomfort and helps in faster healing. However, more comparative and larger studies are needed to highlight its importance in wound healing and to study more indications for its usage in ophthalmology.

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