SCOPE CONNECT

Dexpanthenol in Ophthalmology Mode of Action

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Why is it important to consider using an eye lubricant with dexpanthenol in ophthalmology?

In the UK there are around 400,000 cataract operations annually (Iacobucci, 2019), with around 87% of patients using an artificial tear one-month post-surgery (Roberts CW, 2007). An additional 100,000 people choose laser vision correction with 95% reporting dry eye symptoms up to six months post-surgery (Shtien R, 2011). This is a substantial cohort of patients with potentially reversible Dry Eye disease.

Cataract surgery cuts through all layers of the peripheral cornea, including the nerves (Han K E, 2014; Han K E, 2014) responsible for tearfilm homeostasis (appendix A). Until these and the rest of the corneal tissue repair, dry eye symptoms and signs persist. A key finding in the literature is the importance of speed of repair of the Epithelial Basement Membrane (EBM) to reduce corneal blur (Torricelli A, 2016).

Laser Vision Correction damages the epithelium either with the production of a repositionable flap (LASIK) or epithelial removal Photorefractive Keratectomy (PRK) (Healthline, 2018). In either case the EBM is breached creating an access point for infection (Baron JM, 2020).

It is worth considering the interplay of factors of Dry Eye. From the DEWS II definition, Dry Eye is a multifactorial disease of the ocular surface characterised by a loss of homeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability, hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormality play etiological roles (Wolffsohn, 2017).

Whatever the cause, including surgical, infectious, and accidental injury, patients can neither adequately make nor hold the natural lubricant, leading to the symptoms they experience and observable signs. Without intervention the following stressors form a cycle of inflammation.

Table 1. Corneal repair begins in the presence of the following Corneal and Conjunctival signs and symptoms.

Signs	Test
Inadequate tear quality with reduced tear break-up time marking loss of mucin production, loss of lubricant and evaporation (Wolffsohn, 2017)	Tear Break Up Time (TBUT)
Nerve damage reducing the normal flow of tears (Tear reflex loop) (Wolffsohn, 2017)	Schirmer and Tear Meniscus Height
Epithelial desquamation due to toxic levels of salt; nerve and friction damage, leaving a hydrophobic surface (Rykov S, 2019)	Confocal Microscopy + Lissamine Green
Evaporation (Wolffsohn, 2017) (Kovács, 2016)	Osmolarity measurement (TearLab Corp). Tear Film Thermography for latent heat of evaporation
Lid friction causing conjunctival folds which interfere with eyelid closure and meibum secretion	Lid Parallel Conjunctival Folds (LIPCOF) – slit lamp and OCT observation (Varikooty, 2013)
Patient Symptom scores	Various scales
Visual Acuity	Various measurements, which may be adversely affected by refraction errors due to an unstable tearfilm

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A closer look at how dexpanthanol works to repair and heal

According to standard textbooks Dexpanthenol (pro-vitamin B5) is a stable form of pantothenic acid, readily absorbed topically due to its high solubility in water which also makes it a good moisturiser.

Once absorbed, Dexpanthenol is readily converted to pantothenic acid (vitamin B5). Vitamin B5 is a component of co-enzyme-A, used in the Citric Acid cycle for the metabolism of carbohydrate, fat and protein. It supports the production of energy and generation of such molecules as steroid hormones, fatty acids and acetyl choline. (Ebner, 2002)

Understanding how dexpanthenol works in the skin can aid in the understanding of how it works to repair the cornea.

In skin, pantothenic acid supports the three phases of healing, defined as inflammation, proliferation, and remodelling. Dexpanthenol can aid wound closure, moisturising the wound borders.

In vitro observations using skin cell models and Biopsy-tissue culture show repair is enhanced with Dexpanthenol. Studies on skin wound healing (Weimann and Hermann, 1999) demonstrated that in tissue culture, skin cells migrated to an artificial injury faster with treatment than in the control.

In vivo observations in Skin and Cornea show healing of injuries is enhanced by topical application of Dexpanthenol 2-5% in a suitable gel or ointment. This is attributed to the moisturising effect of DXP which makes the desiccated skin wound borders more supple and helps keep the wound together for faster healing with less scarring.

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It is interesting to note that skin barrier repair, after prolonged challenge (use of detergent), was significantly better with dexpanthenol. (Prosch and Nissen 2002). A dose-ranging study of Dexpanthenol on healthy skin and skin washed with detergent, demonstrated a significant reduction in skin desiccation within two hours of Dexpanthenol application. (Camargo F, 2011)

An in vivo study with skin-plug biopsies showed Dexpanthenol reduces inflammation by acting on a large group of related genes which damp it down (R Heise, 2012). This was a big step forward in understanding how Dexpanthenol helps recruit repair cells to injury sites quickly which in turn can restore damaged skin with reduced scar formation. (Baron JM, 2020).

Clinical data on the effect of dexpanthenol on the repair of corneal damage

Göebbels and Gross (Göebbels M, 1996) demonstrated that Dexpanthenol/Poly Vinyl Alcohol (PVA) eye lubricant gave significant improvement vs Standard of Care in Dry Eye patients. Buchner et al, in a mouse model of corneal epithelial healing, demonstrated Dexpanthenol or Hyaluronic Acid on their own improved re-epithelialisation but in combination the improvement was additive (Buchner F., 2009).

Raczyńska et al. used Dexpanthenol/Hyaluronic Acid eye lubrication post corneal and conjunctival surgery or injury (Raczyńska K, 2003). Half the group of 80 eyes drew Dexpanthenol and half did not. Importantly, the differences between the two groups commenced on the second day. Better effects were observed in patients receiving dexpanthenol. Congestion and oedema of conjunctiva reduced, the edges of wounds demonstrated smoothness and better adherence. Subjective feelings improved.

Rykov et al. studied a fixed combination of hyaluronic acid and dexpanthenol in improving the anterior ocular surface after cataract surgery (Rykov S, 2019). Sixty patients were randomised to two groups, one with Dexpanthenol/Hyaluronic acid and the control group without.

Patients were assessed before and one month after cataract surgery for standard Ocular surface markers, plus laser-scanning confocal microscopy for Oxford Corneal staining and Corneal epithelial cell condition, with a visual analogue scale of subjective symptoms. Patients in the treatment group had significantly better outcomes than the control arm across all parameters.

Tearfilm stability, meniscus height, aqueous production and Corneal surface epithelial health. Patients in the control arm were measured to have poorer indicators of Ocular surface health than before treatment with unchanged Schirmer I and Oxford staining.

The authors report that the fixed combination of Dexpanthenol/ Hyaluronic acid is effective in improving the anterior ocular surface after cataract surgery.

Summary

The contribution by Dexpanthenol to skin healing has encouraged Ophthalmology researchers to evaluate it in combination with Hyaluronic Acid eye lubricant drops in corneal injury after surgery.

The good news is that post-traumatic Dry Eye is substantially reversible, and that Dexpanthenol-Hyaluronic Acid fixed combination eye lubrication can speed it, with better outcomes.

Conclusion

With the high prevalence of cataract surgery and the need for accelerated healing of the cornea to promote patient comfort and attenuate the risk of chronic dry eye, the use of a lubricant with dexpanthenol offers an effective treatment choice to help achieve these patient outcomes.

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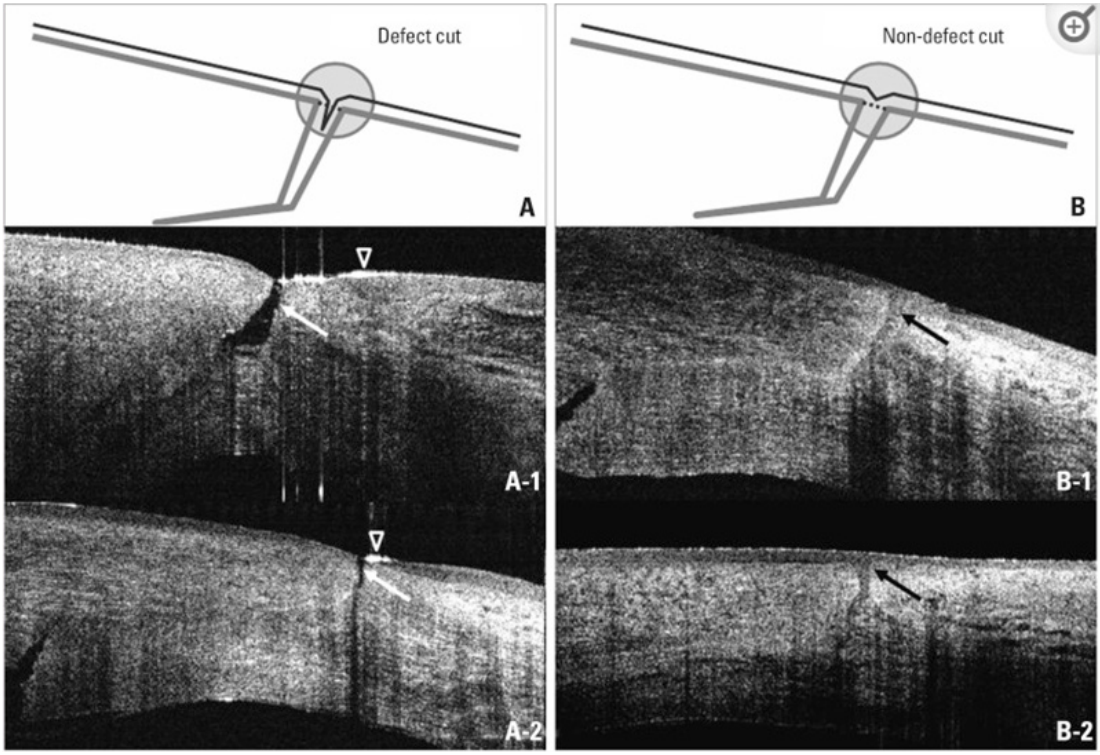
Appendix A - Corneal defect imaging following surgery (Han K E, 2014)



(A) Representative images showing the defect and non-defect image cuts in images of the fourier-domain optical coherence tomography. (A and B) An imaginary line (red dotted line) was drawn connecting Bowman layer on both ends of the sectional plane. (A-1 and A-2) Cases showing a lack of epithelium on the imaginary line and a discontinuation of this line were interpreted as a defect cut. The black hollow spaces without epithelial growth were noted (white arrows). The layer of powerfully bright light is considered to be a reflection of the tear fluid (white hollow arrowheads). (B-1 and B-2) Case showing epithelial growth both above this line and without interruptions were interpreted as a non-defect image cut. The spaces in the incision site were occupied with epithelial growth which showing similar dark grey colour with the epithelial layer (black arrows)

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