

# Punctum plugs in the management of dry eye

**With estimated prevalence ranging from 7.8% to 93.2% from different studies worldwide, dry eye disease (DED) is probably the most common ocular condition seen by eye care practitioners.<sup>1-4</sup>**

Apparently, Asian studies report higher prevalence than those from western countries and the 3 studies from India report the prevalence between 18.4% and 40.8%.<sup>4</sup> Despite the common use of the term 'dry eye' in ophthalmic literature, there was no formal definition of dry eye as recently as 1995.<sup>4</sup> The currently used definition of dry eye was proposed by the 2007 International Dry Eye Workshop (DEWS), "Dry eye is a multi-factorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface."<sup>5</sup>

With the widespread use of video display terminals (TVs, computers, iPads, smart phones), increasing acceptance of contact lens use and laser refractive surgery, hormonal changes (reduced androgen levels, exogenous estrogen use) and imbalance in the dietary intake of essential fatty acids;<sup>6</sup> there seems to be a change in demographics of dry eye patients. While dry eye used to be considered predominantly an old age condition, these days an increasing number of younger people are getting diagnosed with dry eye, affecting their everyday social and physical functioning, work place productivity, and quality-of-life.<sup>7, 8</sup>

The most commonly used first-line therapy for the DED is largely palliative i.e., topically administered artificial tear substitutes, which provide basic lubrication to the eye surface.<sup>8</sup> Although mild cases of DED, in which there are no signs of damage to the conjunctiva or cornea, may be successfully managed with artificial tears applied up to four times per day;<sup>9</sup> in moderate or severe cases, improvement is short-lived because the tears drain through the lacrimal outflow channels and evaporate.<sup>10</sup> Since the retention of artificial tear supplements on the eye is poor, they need to be used frequently up to once in every 1-2 hours.<sup>9, 11</sup>

Additionally, compliance is known to significantly decrease if the dosing schedule is more than twice a day; therefore, poor compliance may substantially limit the benefits obtainable from artificial tears. While more viscous drops may increase the lubricants retention time and decrease the dosing frequency to a reasonable range, they tend to blur the vision and may leave more residual foreign particles in the eye.<sup>12</sup>

**TABLE 1**  
**Benefits of Punctal Occlusion**

#### Improvement in tear dynamics:

- Increase in tear volume (Schirmer's test)<sup>14-17</sup>
- Improvement in tear retention time<sup>18</sup>
- Decreasing elevated tear osmolarity<sup>14</sup>
- Improvement in tear stability (tear break up time, TBUT)<sup>14, 15, 18-20</sup>

#### Improvement in ocular surface health:

- Decrease in the ocular surface staining (corneal as well as conjunctival)<sup>10, 14, 16, 21-23</sup>
- Increase in mucin goblet cell density<sup>14</sup>
- Improvement in corneal filaments, corneal erosion and ulcers, and blepharitis.<sup>14</sup>

#### Improvement in dry eye symptoms and visual acuity:

- Relief in dry eye symptoms such as discomfort and itching.<sup>14</sup>
- Improvement in contact lens tolerance.<sup>14, 24</sup>
- Reduction of higher order wavefront aberrations of post-LASIK eyes<sup>25</sup>
- Improvement in visual acuity<sup>19</sup>

#### Improvement in dosing frequency of artificial tears and indirectly compliance:

- Reduction in the number of artificial tear instillations, thereby improving compliance and reducing the cost of artificial tear therapy, especially in moderate or severe dry eye patients<sup>13, 14</sup>
- Patients who are unable to use eye drops because of occupational, physical, or psychological limitations, may benefit from punctum plugs<sup>14</sup>

Punctal occlusion is a simple procedure that blocks the lacrimal outflow system at the level of the punctum or canaliculus and aims to conserve the naturally produced tears in aqueous deficient dry eye and also to prolong the contact time of artificial tears.<sup>13</sup> The use of punctum plug occlusion has been reported to improve the tear dynamics, ocular surface health, visual acuity, and decrease dry eye symptoms (Table 1).<sup>11</sup> Although punctal occlusion is specifically indicated in the aqueous deficient dry eye, as such, any type of dry eye (Table 2) may improve with canalicular blocking, because the deficits are interrelated, each affecting the other to some extent.<sup>14</sup>

### Criteria for performing punctal/canalicular occlusion

Typical criteria used to decide implantation of punctum plugs includes aqueous insufficiency as indicated by Schirmer's test (with anaesthesia) of  $\leq 5$  mm at 5 min and presence of conjunctival/corneal staining.<sup>14, 30</sup> It is important to note that for a successful punctal occlusion, at least some amount of aqueous secretion must be present.<sup>14</sup> On the contrary, punctum plug implantation should be avoided in patients with mild dry eye (typically with Schirmer's test of  $> 5$  mm) so as to reduce the risk of post-occlusion epiphora.<sup>10</sup> Further, the punctum plug should also be usually avoided in patients with immune-compromised status because of high risk of infection in these patients.<sup>31</sup>

### Planning for punctal occlusion

Although rare, sub-clinical naso-lacrimal duct occlusion may be present and punctum implantation in such a case

TABLE 2

### Indications for Punctal Occlusion

- Moderate to severe aqueous-deficient dry eye (not responding to artificial tears, poor compliance to the use of artificial tears)<sup>14</sup>
- keratoconjunctivitis sicca (KCS)<sup>14</sup>
- Post-LASIK dry eye<sup>25</sup>
- Contact lens intolerance<sup>26</sup>
- Superior limbic keratoconjunctivitis.<sup>27</sup>
- Sjogren syndrome<sup>19, 21</sup>
- Stevens-Johnson syndrome<sup>19, 28</sup>
- ocular cicatricial pemphigoid<sup>19</sup>
- Rheumatoid arthritis<sup>10</sup>
- filamentary keratopathy<sup>10</sup>
- Superior limbic keratoconjunctivitis<sup>29</sup>
- Ocular surface epitheliopathy<sup>29</sup> associated with
  - Penetrating keratoplasty
  - Neurotrophic keratopathy
  - Recurrent corneal erosions
  - Toxic epitheliopathy

may completely isolate the lacrimal sac, thereby increasing risk of acute dacryocystitis. Therefore, before performing punctal occlusion, it is important to perform lacrimal irrigation to ensure the patency of the nasolacrimal duct.<sup>14, 32, 33</sup>

Ocular surface inflammation is commonly associated with dry eye. It is recommended that ocular surface inflammation be treated prior to performing punctal occlusion, because punctal occlusion in these patients may potentially worsen their symptoms by delaying their tear clearance and increasing the concentrations of pro-inflammatory cytokines (e.g. interleukin-1a) in the tear fluid.<sup>17, 29</sup>

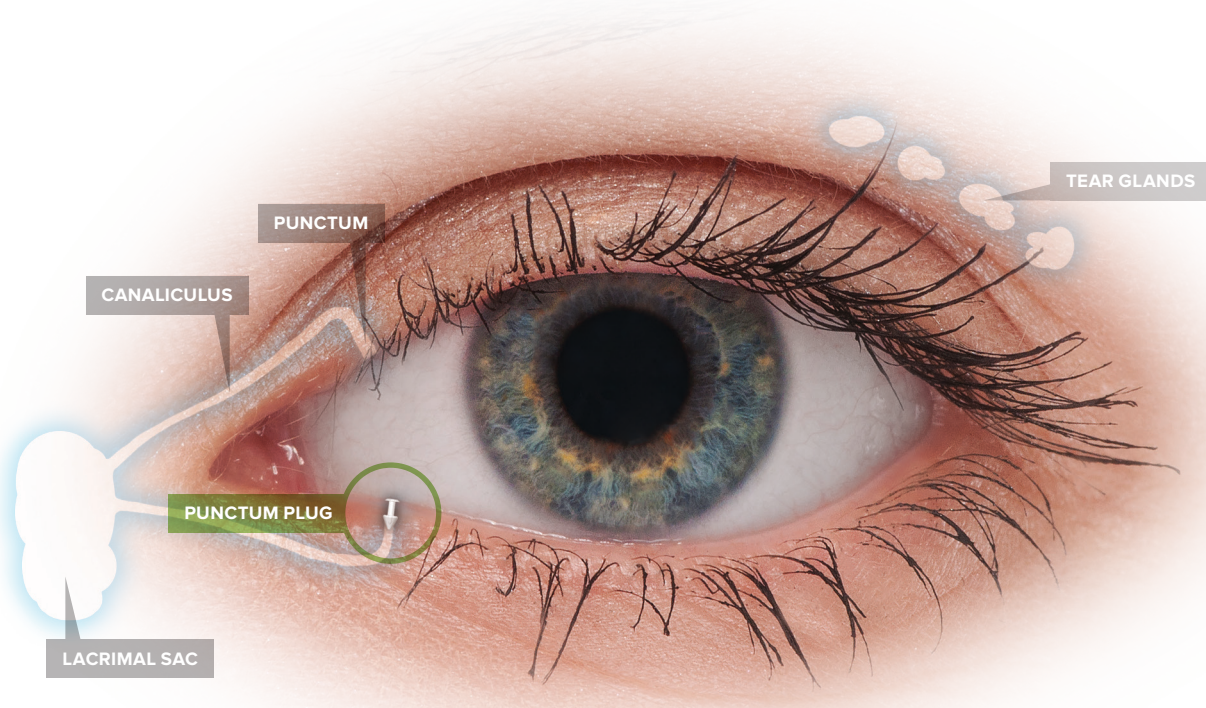
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### Upper vs lower vs both punctum occlusion

The inferior punctum is larger and more accessible than superior one.<sup>34</sup> Therefore, occlusion of only the inferior punctum is expected to produce sufficient relief.<sup>35</sup> Correspondingly, there is data to support that occluding both upper and lower puncta offers no practical beneficial gain compared with occluding just the lower punctum.<sup>11</sup> In contrast, there is also evidence to suggest that anatomical difference between lower and upper punctal is not associated with any difference in tear drainage between the upper and lower canaliculi.<sup>34</sup> Therefore, when occlusion of the lower punctum is not sufficient, the upper punctum can be occluded, usually achieving improved results.<sup>26</sup>

### Absorbable vs non-absorbable punctum plugs

Various designs and models of punctum plugs are available, made of absorbable [short-term (7-10 days) implantation with collagen plug or extended duration (60-180 days) implantation with plugs made from E-Caprolactone-L-Lactide copolymer] or permanent plugs made of non-absorbable material e.g., silicone. To determine the effect of treatment on dry eye symptoms and to evaluate epiphora tolerance in patient, short-term temporary occlusion by a reversible means is often preferable initially, before considering a long-term occlusion.<sup>10, 14</sup> While short term absorbable plugs have the advantage of easy insertion and relatively rapid spontaneous dissolution; non-absorbable plugs provide long-term occlusion until

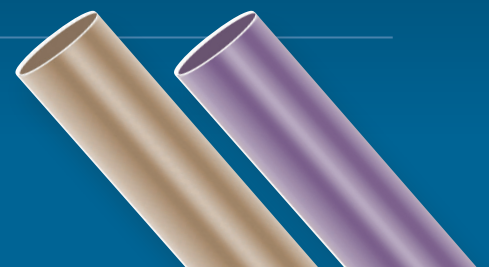
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removed or extruded; however, both absorbable and non-absorbable punctum plugs have been demonstrated with similar efficacy for dry eye in the short term.<sup>36</sup>

### Sizing of the plug

Appropriate sizing of the punctum plug plays an important role in achieving successful occlusion. To avoid over or under sizing, a punctal gauging instrument is preferable over subjective visual inspection to choose the correct plug size.<sup>13</sup> An appropriate size is one that is snug fit and requires gentle pressure for insertion and removal.<sup>37</sup> It is important to ensure that the plug is not oversized which may cause the punctal annulus to be overly stretched, potentially increasing the risk of punctal migration or extrusion.

### Alternative uses of the punctum plugs (Glaucoma)

There is also evidence to suggest that increased contact time between the medication and the ocular surface following punctal occlusion might enhance the bioavailability of topical medications. For example, punctal occlusion has been found to enhance the intraocular pressure (IOP) lowering effect of topical glaucoma medications.<sup>38</sup>

### References

1. Wlodarczyk J, Fairchild C. United States cost-effectiveness study of two dry eye ophthalmic lubricants. *Ophthalmic Epidemiol* 2009;16:22-30.
2. McCarty CA, Bansal AK, Livingston PM, et al. The epidemiology of dry eye in Melbourne, Australia. *Ophthalmology* 1998;105:1114-9.
3. Bukhari A, Ajjan R, Alsaggaf H. Prevalence of dry eye in the normal population in Jeddah, Saudi Arabia. *Orbit* 2009;28:392-7.
4. Basak SK. Dry Eye Disease. Preferred Practice Pattern Document: ALL INDIA OPHTHALMOLOGICAL SOCIETY, 2013.
5. The definition and classification of dry eye disease: report of the Definition and Classification Subcommittee of the International Dry Eye WorkShop (2007). *Ocul Surf* 2007;5:75-92.
6. Schaumberg DA, Dana R, Buring JE, Sullivan DA. Prevalence of dry eye disease among US men: estimates from the Physicians' Health Studies. *Arch Ophthalmol* 2009;127:763-8.
7. Uchino M, Schaumberg DA, Dogru M, et al. Prevalence of dry eye disease among Japanese visual display terminal users. *Ophthalmology* 2008;115:1982-8.
8. Asbell PA, Lemp MA. Dry Eye Disease: The Clinician's Guide to Diagnosis and Treatment: Thieme, 2011.
9. Yavuz B, Bozdog Pehlivan S, Unlu N. An overview on dry eye treatment: approaches for cyclosporin a delivery. *ScientificWorldJournal* 2012;2012:194848.
10. Punctal occlusion for the dry eye. Three-year revision. *American Academy of Ophthalmology. Ophthalmology* 1997;104:1521-4.
11. Farrell J, Patel S, Grierson DG, Sturrock RD. A clinical procedure to predict the value of temporary occlusion therapy in keratoconjunctivitis sicca. *Ophthalmic Physiol Opt* 2003;23:1-8.
12. Simmons PA, Vehige JG. Clinical performance of a mid-viscosity artificial tear for dry eye treatment. *Cornea* 2007;26:294-302.
13. Bourkiza R, Lee V. A review of the complications of lacrimal occlusion with punctal and canaliculal plugs. *Orbit* 2012;31:86-93.
14. Murube J, Murube E. Treatment of dry eye by blocking the lacrimal canaliculi. *Surv Ophthalmol* 1996;40:463-80.
15. Alfawaz AM, Algehedan S, Jastaneiah SS, et al. Efficacy of punctal occlusion in management of dry eyes after laser in situ keratomileusis for myopia. *Curr Eye Res* 2014;39:257-62.
16. Dursun D, Ertan A, Bilezikci B, et al. Ocular surface changes in keratoconjunctivitis sicca with silicone punctum plug occlusion. *Curr Eye Res* 2003;26:263-9.
17. Roberts CW, Carniglia PE, Brazzo BG. Comparison of topical cyclosporine, punctal occlusion, and a combination for the treatment of dry eye. *Cornea* 2007;26:805-9.
18. Chen F, Shen M, Chen W, et al. Tear meniscus volume in dry eye after punctal occlusion. *Invest Ophthalmol Vis Sci* 2010;51:1965-9.
19. Kaido M, Ishida R, Dogru M, et al. Efficacy of punctum plug treatment in short break-up time dry eye. *Optom Vis Sci* 2008;85:758-63.
20. Kaido M, Ishida R, Dogru M, Tsubota K. A new punctal plug insertion technique to prevent intracanalicular plug migration. *Am J Ophthalmol* 2009;147:178-82 et al.
21. Sakamoto A, Kitagawa K, Tatami A. Efficacy and retention rate of two types of silicone punctal plugs in patients with and without Sjogren syndrome. *Cornea* 2004;23:249-54.
22. Ishida R, Kojima T, Dogru M, et al. The application of a new continuous functional visual acuity measurement system in dry eye syndromes. *Am J Ophthalmol* 2005;139:253-8.
23. Sabti S, Halter JP, Braun Frankl BC, Goldblum D. Punctal occlusion is safe and efficient for the treatment of keratoconjunctivitis sicca in patients with ocular GVHD. *Bone Marrow Transplant* 2012;47:981-4.
24. Li M, Wang J, Shen M, et al. Effect of punctal occlusion on tear menisci in symptomatic contact lens wearers. *Cornea* 2012;31:1014-22.
25. Huang B, Mirza MA, Qazi MA, Pepose JS. The effect of punctal occlusion on wavefront aberrations in dry eye patients after laser in situ keratomileusis. *Am J Ophthalmol* 2004;137:52-61.
26. Tai MC, Cosar CB, Cohen EJ, et al. The clinical efficacy of silicone punctal plug therapy. *Cornea* 2002;21:135-9.
27. Balaram M, Schaumberg DA, Dana MR. Efficacy and tolerability outcomes after punctal occlusion with silicone plugs in dry eye syndrome. *Am J Ophthalmol* 2001;131:30-6.
28. Kaido M, Goto E, Dogru M, Tsubota K. Punctal occlusion in the management of chronic Stevens-Johnson syndrome. *Ophthalmology* 2004;111:895-900.
29. Yen MT, Pflugfelder SC, Feuer WJ. The effect of punctal occlusion on tear production, tear clearance, and ocular surface sensation in normal subjects. *Am J Ophthalmol* 2001;131:314-23.
30. Knapp ME, Frueh BR, Nelson CC, Musch DC. A comparison of two methods of punctal occlusion. *Am J Ophthalmol* 1989;108:315-8.
31. Tabbara KF. *Aspergillus fumigatus* colonization of punctal plugs. *Am J Ophthalmol* 2007;143:180-1.
32. Glatt HJ. Acute dacryocystitis after punctal occlusion of keratoconjunctivitis sicca. *Am J Ophthalmol* 1991;111:769-70.
33. Marx JL, Hillman DS, Hinshaw KD, et al. Bilateral dacryocystitis after punctal occlusion with thermal cautery. *Ophthalmic Surg* 1992;23:560-1.
34. Chen F, Wang J, Chen W, et al. Upper punctal occlusion versus lower punctal occlusion in dry eye. *Invest Ophthalmol Vis Sci* 2010;51:5571-7.
35. Brightbill FS. *Corneal Surgery: Theory, Technique and Tissue*: Mosby, 2009.
36. Altan-Yaycioglu R, Gencoglu EA, Akova YA, et al. Silicone versus collagen plugs for treating dry eye: results of a prospective randomized trial including lacrimal scintigraphy. *Am J Ophthalmol* 2005;140:88-93.
37. Hamano T. Lacrimal duct occlusion for the treatment of dry eye. *Semin Ophthalmol* 2005;20:71-4.
38. Optiz DL, Tung S, Jang US, Park JJ. Silicone punctal plugs as an adjunctive therapy for open-angle glaucoma and ocular hypertension. *Clin Exp Optom* 2011;94:438-42.