

FLUORESCEIN CLEARANCE TEST (TEAR DYNAMIC FUNCTIONAL TEST)

1. Ocular Surface Center Code: T 3001

2. Introduction:

The ocular surface is covered by a thin layer of precorneal tear film, of which the aqueous fluid is secreted by the lacrimal gland, spread over the entire ocular surface by lid blinking, and then cleared from the eye into the nose through the nasolacrimal drainage system. Therefore, a complete knowledge of all hydrodynamic elements, i.e., *tear secretion (flow)*, *tear volume*, and *tear clearance or turnover*, is important for complete evaluation of tear dynamic function..

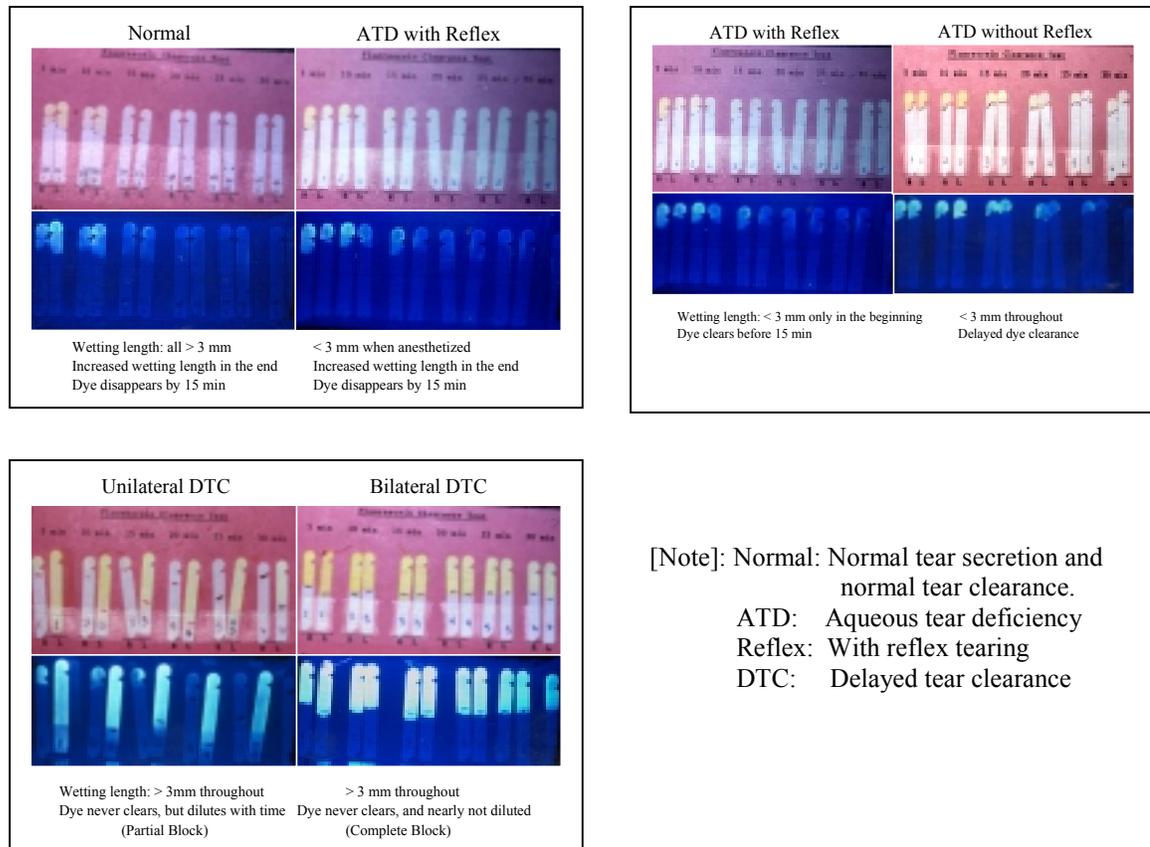
Clinically, measurement of tear secretion relies on the Schirmer test. However, one common way of measuring tear clearance is to judge the speed of disappearance from the ocular surface of exogenously added fluorescein, a method originally used by Nover and Jaeger¹. Various methods have been developed and can be grossly subdivided into two major groups. The first group detects how fast the dye appears in the nasal cavity. This is accomplished by the use of a Q tip in the traditional Jones I test², or by direct visualization through endoscopy³. The second group measures how slow the dye is still retained on the ocular surface. This can be achieved by visual semiquantitation^{4,5}, wetting with Schirmer strips¹, or fluorophotometry⁶, of which the latter can be directed to the marginal strip^{6,7} or to the precorneal tear film⁸⁻¹¹.

3. Method of Operation:

As reported¹²⁻¹⁵, the fluorescein clearance test (FCT) is performed as follows. After applying one drop of 0.5 % proparacaine (Alcon Laboratories, Inc., Humacao, PR) to each eye, the inferior fornix was carefully dried with tissue paper. An aliquot of 5 µl of Fluorescein^R (Akorn Inc., Abita Springs, LA) containing 0.25 % fluorescein and 0.4 % benoxinate hydrochloride was then applied to the inferior fornix of each eye through an Eppendorf pipette (Rainin Instrument Co., Woburn, MA) without directly touching the conjunctival surface. The patient continued to sit in the examination room under the ambient light and was asked to blink normally. After a lapse of 10 min, determined by a timer, a Schirmer paper strip (Alcon Laboratories, Inc., Fort Worth, TX) was inserted into the inferior fornix of each eye at a position approximately one third lateral to the temporal caruncle. After one min, during which time the eye is closed. This maneuver was repeated for a total of 3 times over a period of 30 min, i.e., every 10 min. At the end of the 30 min, i.e., the last test, Schirmer strip was inserted after nasal stimulation with a Q-tip.

4. Interpretation:

The FCT allows one to determine the following three important tear dynamic functions, i.e., basal tear secretion, reflex tear secretion under nasal stimulation, and tear clearance, at the same time.



5. Clinical Uses:

- 1) To determine aqueous tear deficiency (dry eye) with higher accuracy^{15,16}
- 2) To differentiate dry eye into with or without reflex tearing. Sjogren syndrome or primary lacrimal gland diseases are characterized by the loss of reflex tearing¹⁷, thus helping establish the severity of dry eye
- 3) To guide physicians to perform punctal occlusion with plugs or permanent cauterization
- 4) To determine if punctal occlusion is performed with efficacy
- 5) To determine subclinical DTC as a cause of ocular irritation, medicamentosa and other ocular surface disorders^{14,18-20}, and help direct more effective treatments such as non-preserved methylprednisolone^{14,21}

6. Literature:

1. Nover A, Jaeger W. Kolorimetrische Methode zur Messung der Tranensekretion (Fluoreszein-Verdunnungstest). *Klin Mbl Augenheilk.* 1952;121:419-425.
2. Jones LT. The lacrimal secretory system and its treatment. *Am J Ophthalmol.* 1966;62:47-60.
3. Tucker NA, Codere F. The effect of fluorescein volume on lacrimal outflow transit time. *Ophthalm Plast & Reconstr Surg.* 1994;10:256-259.
4. Norn MS. Tear secretion in normal eyes. Estimated by a new method: the lacrimal streak dilution test. *Acta Ophthalmol (Copenh).* 1965;43:567-573.
5. Zappia RJ, Milder B. Lacrimal drainage function. 2. The fluorescein dye disappearance test. *Am J Ophthalmol.* 1972;74:160-162.
6. Mishima S, Gasset A, Klyce SDJr, Baum JL. Determination of tear volume and tear flow. *Invest Ophthalmol.* 1966;5:264-276.
7. Jordan A, Baum J. Basic tear flow. Does it exist? *Ophthalmology.* 1980;87:920-930.
8. Puffer MJ, Neault RW, Brubaker RF. Basal precorneal tear turnover in the human eye. *Am J Ophthalmol.* 1980;89:369-376.
9. Webber WRS, Jones DP, Wright P. Fluorophotometric measurements of tear turnover rate in normal healthy persons: evidence for a circadian rhythm. *Eye.* 1987;1:615-620.
10. Occhipinti JR, Mosier MA, LaMotte J, Monji GT. Fluorophotometric measurement of human tear turnover rate. *Curr Eye Res.* 1988;7:995-1000.
11. van Best JA, Benitez del Castillo JM, Coulangeon L-M. Measurement of basal tear turnover using a standardized protocol. European concerted action on ocular fluorometry. *Graefe's Arch Clin Exp Ophthalmol.* 1995;233:1-7.
12. Linden C, Alm A. The effect of reduced tear drainage on corneal and aqueous concentrations of topically applied fluorescein. *Acta Ophthalmol (Copenh).* 1990;68 :633-638.
13. Pflugfelder SC, Tseng SCG, Pepose JS, Fletcher MA, Klimas N, Feuer W. Epstein-Barr virus infection and immunological dysfunction in patients with aqueous tear deficiency. *Ophthalmology.* 1990;97:313-323.

14. Prabhasawat P, Tseng SCG. Frequent association of delayed tear clearance in ocular irritation. *Br J Ophthalmol.* 1998;182:666-675.
15. Xu K-P, Yagi Y, Toda I, Tsubota K. Tear function index. A new measure of dry eye. *Arch Ophthalmol.* 1995;113:84-88.
16. Pflugfelder SC, Tseng SCG, Sanabria O, Kell H, Garcia CG, Felix C, Feuer W, Reis BL. Evaluation of subjective assessments and objective diagnostic tests for diagnosing tear-film disorders known to cause ocular irritation. *Cornea.* 1998;17:38-56.
17. Anderson DF, Prabhasawat P, Alfonso E, Tseng SCG. Amniotic membrane transplantation after the primary surgical management of band keratopathy. *Cornea.* 2001;20:354-361.
18. Barton K, Monroy D, Nava A, Pflugfelder SC. Inflammatory cytokines in tears of patients with ocular rosacea. *Ophthalmology.* 1997;104:1868-1874.
19. Afonso AA, Sobrin L, Monroy DC, Selzer M, Lokeshwar B, Pflugfelder SC. Tear fluid gelatinase B activity correlates with IL-1 α concentration and fluorescein clearance in ocular rosacea. *Invest Ophthalmol Vis Sci.* 1999;40:2506-2512.
20. Afonso AA, Monroy D, Stern ME, Tseng SCG, Pflugfelder SC. Correlation of tear fluorescein clearance and Schirmer test scores with ocular irritation symptoms. *Ophthalmology.* 1999;106:803-810.
21. Marsh P, Pflugfelder SC. Topical nonpreserved methylprednisolone therapy for keratoconjunctivitis sicca in Sjogren syndrome. *Ophthalmology.* 1999;106:811-816.