Journal of Optometry (2018) xxx, xxx–xxx

Journal of Optometry

www.journalofoptometry.org

REVIEW

Tear instability importance, mechanisms, validity and reliability of assessment

Charles W. Mcmonnies*

School of Optometry and Vision Science, University of New South Wales, Kensington 2052, Australia

Received 26 July 2017; accepted 29 November 2017

KEYWORDS
Dry eye;
Tear instability;
Break up time

Abstract
Purpose: To examine the factors which contribute to tear stability and the validity and reliability of methods used for assessing tear break up time which is a core part of an examination of tear stability in dry eye patients.
Methods: A review of publications which are relevant to tear stability and its assessment.
Results: Tear break up time may be more invasive than intended if difficulty avoiding blinking during assessment results in reflex tearing. Notwithstanding control of instilled volume and concentration of fluorescein, on-eye dilution is highly variable according to resident tear volume. Blinking to evenly distribute fluorescein may improve tear and lipid layer thickness so habitual tear function is not assessed. Emphasis on a role for Meibomian gland dysfunction as a cause of tear instability may be appropriate in many cases but ignores the roles for other sources of tear lipid and other non-lipid contributions to tear instability such as aqueous or mucus deficiency, desiccated epitheliopathy or anomalous blinking. Objective less-invasive methods eliminate problems of inter-observer variability and can reliably 'maintain vigilance' over wide areas of the tear layer. However less-invasive results to date include mean tear break up findings which are both shorter and longer than expected for normal controls.
Conclusions: Fluorescein tear break up time assessments cannot be standardised and less-invasive methods are not yet standardised. Objective less-invasive and subjective fluorescein break up time tests do not appear to be measuring the same tear phenomena although both should be performed before other invasive procedures.

* Correspondence to: 77 Cliff Avenue, Northbridge, Sydney, New South Wales 2000, Australia.
E-mail address: c.mcmonnies@unsw.edu.au

https://doi.org/10.1016/j.optom.2017.11.004

Please cite this article in press as: Mcmonnies CW. Tear instability importance, mechanisms, validity and reliability of assessment. *J Optom.* (2018), https://doi.org/10.1016/j.optom.2017.11.004

PALABRAS CLAVE
Ojo seco;
Inestabilidad de la lágrima;
Tiempo de ruptura

Importancia, mecanismos, validez y fiabilidad de la evaluación de la inestabilidad de la lágrima

Resumen
Objetivo: Examinar los factores que contribuyen a la estabilidad de la lágrima y a la validez y fiabilidad de los métodos utilizados para evaluar el tiempo de ruptura lagrimal, que forma parte esencial del examen de la estabilidad de la lágrima en los pacientes con ojo seco.
Métodos: Revisión y evaluación de las publicaciones relevantes en cuanto a estabilidad de la lágrima.
Resultados: La evaluación del tiempo de ruptura lagrimal puede ser más invasiva de lo previsto cuando la dificultad para evitar el parpadeo durante la evaluación origina un lagrimeo reflejo. No obstante el control del volumen instilado y la concentración de fluoresceína, la dilución en el ojo es altamente variable en función del volumen lagrimal residente. El parpadeo para distribuir uniformemente la fluoresceína puede mejorar la lágrima y el espesor de la capa lipídica, por lo que la función lagrimal habitual no se evalúa. Enfatizar el papel de la disfunción de la glándula de Meibomio como causa de la inestabilidad de la lágrima puede ser adecuado en muchos casos, pero ignora el papel de otras fuentes de lípidos lagrimales y las contribuciones no lipídicas a la inestabilidad de la lágrima tales como la deficiencia acuosa o mucosa, la epiteliopatía por sequedad o el parpadeo anómalo. Los métodos objetivos menos invasivos eliminan los problemas de variabilidad inter-observador, y pueden' mantener la vigilancia' fidedignamente sobre otras grandes áreas de la capa lagrimal. Sin embargo, hasta la fecha los resultados menos invasivos conllevan hallazgos sobre el tiempo de ruptura lagrimal medio que pueden ser más breves y más prolongados de lo esperado en los controles normales.
Conclusiones: No pueden estandarizarse las evaluaciones del tiempo de ruptura lagrimal con fluoresceína, y aún no se han estandarizado métodos menos invasivos. No parece que las pruebas menos invasivas de evaluación objetiva y subjetiva del tiempo de ruptura con fluoresceína midan los mismos fenómenos lagrimales, aunque ambas pruebas deberán realizarse previamente a otros procedimientos invasivos.

Assessment of tear break up time (TBUT) is a core measure of tear stability and its measurement is a major cornerstone of clinical tests for dry eye[1–3] as an indication of the rate of tear loss by evaporation. This measurement has the potential to capture the combined contributions of lipid, mucin and aqueous deficiencies to tear instability for example. This review examines the mechanisms and factors which determine tear stability and instability as well as the variables involved in their measurement because the methods used to achieve reliable assessments and to establish appropriate diagnostic criteria depend on the degree of understanding and control over those variables. PubMed searches using the terms 'tear break up time tests', 'tear instability', and 'tear evaporation' yielded 382, 2306 and 313 potentially relevant publications respectively. Selections from these lists were made to examine the evidence which appears to be the most relevant for examining the mechanisms and variables which determine tear stability as well as to assessing the validity and reliability of measuring TBUT as an indication of tear stability.

The potential significance of evaporation in aqueous deficient dry eye (ADDE) when tear stability is normal range

Although excessive evaporation is a core factor in cases of evaporative dry eye (EDE)[4] even normal evaporation rates can be important contributors to the symptoms which develop in ADDE. Notwithstanding normal lipid and mucin functions in some cases, very thin tear layers in ADDE eyes are susceptible to TBU and associated symptoms due to tear loss which occurs with normal rates of evaporation. This relationship is indicated by the finding that, compared to normal controls with a mean fluorescein TBUT (FTBUT) of 7.1 s, mean FTBUT for patients with ADDE was 2.1 s.[5] Similarly, mean non-invasive TBUT (NITBUT) was found to be 3.3 s for non-Sjogren's Syndrome ADDE subjects compared to 6.6 s for subjects with MGD and normal tear layer thickness.[6] Consequently, ADDE may include symptoms with an evaporative basis which are similar to those which develop in EDE which occurs without an ADDE component. The susceptibil-

Please cite this article in press as: Mcmonnies CW. Tear instability importance, mechanisms, validity and reliability of assessment. *J Optom.* (2018), https://doi.org/10.1016/j.optom.2017.11.004