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Original Article

Efficacy of 0.5% Oral Glucose vs Lubricants on Tear Break Up Time in Blepharitis Patients

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ABSTRACT

Background: Blepharitis is a chronic inflammatory eyelid disorder associated with tear-film instability and reduced tear breakup time (TBUT), contributing to dry eye symptoms and impaired visual function. While topical lubricants remain the standard treatment for improving tear-film stability, the role of systemic metabolic modulation, such as oral glucose, in influencing TBUT remains unclear. Objective: To evaluate and compare the short-term effects of 0.5% oral glucose solution and lubricant therapy on tear breakup time in patients with mild-to-moderate blepharitis. Methods: A prospective comparative interventional study was conducted on 42 participants aged 18–25 years with clinically diagnosed blepharitis, allocated into two groups: oral glucose (n=21) and lubricant (n=21). Baseline TBUT was measured using fluorescein slit-lamp examination, followed by reassessment at 30 and 120 minutes post-intervention. Statistical analysis was performed using SPSS version 21.0, with independent t-tests applied to compare mean TBUT between groups. Results: Baseline TBUT was comparable between groups ($p>0.05$). At 30 minutes, the glucose group showed greater improvement, particularly in the left eye (mean difference: 0.87 seconds; $p=0.018$), with a significant within-group increase (+1.11 seconds; $p=0.001$). At 120 minutes, TBUT declined in the glucose group but remained higher in the lubricant group, although differences were not statistically significant ($p>0.05$). Conclusion: Oral 0.5% glucose demonstrated a transient short-term improvement in TBUT, whereas lubricants provided more sustained tear-film stabilization. These findings support lubricants as the primary treatment modality, with oral glucose showing limited adjunctive potential. Keywords: Blepharitis, Tear Breakup Time, Oral Glucose, Lubricants, Dry Eye Disease, Tear Film Stability.

INTRODUCTION

Blepharitis is a chronic inflammatory disorder of the eyelid margin that commonly arises from bacterial colonization, seborrheic skin disease, and meibomian gland dysfunction, and is frequently accompanied by ocular surface irritation, redness, burning, foreign-body sensation, fluctuating vision, and tear-film instability (1,2). Beyond local lid disease, blepharitis has important functional consequences because disruption of the lipid layer increases tear evaporation and shortens tear breakup time, thereby contributing to evaporative dry eye and worsening patient comfort and visual quality (2-4). Tear-film instability is clinically relevant because a reduced tear breakup time is associated with optical aberrations, reduced contrast sensitivity, intermittent blurring, and greater symptom burden during visually demanding tasks such as reading and screen use (5,6). In routine clinical practice, a tear breakup time below 10 seconds is generally considered suggestive of tear-film instability, and reduced values are consistently observed in patients with dry eye disease, including those with blepharitis-related ocular surface dysfunction (7).

The relationship between blepharitis and dry eye is now understood as biologically intertwined rather than as two entirely separate disorders. Meibomian gland dysfunction, lid-margin inflammation, microbial overgrowth, and altered tear-film composition collectively destabilize the preocular tear film and perpetuate a self-sustaining inflammatory cycle affecting both the eyelids and ocular surface (2,8,9). This overlap has direct therapeutic implications. Lubrication remains a mainstay of treatment because artificial tears can transiently improve tear-film stability, reduce surface friction, dilute inflammatory mediators, and in some formulations supplement the compromised lipid layer that is characteristic of blepharitis-associated evaporative dry eye (2,10,11). Prior work has shown that lubricant composition influences tear-film behavior, and formulations containing polymers or lipid-supportive components may improve tear stability to varying degrees in symptomatic patients (11,12). Nevertheless, the response to lubricants is often incomplete, short-lived, and influenced by the underlying pathophysiology of lid disease, underscoring the need to explore additional or adjunctive approaches for improving tear-film stability in blepharitis (2,9,12).

Interest in metabolic influences on ocular surface homeostasis has increased in recent years. Systemic metabolic disturbances, including abnormalities in glucose regulation and other components of metabolic syndrome, have been linked to ocular surface dysfunction, meibomian gland changes, and altered tear-film properties (13,14). Observational evidence also suggests that dry eye and reduced tear breakup time may be more frequent in individuals with diabetes and in those with posterior blepharitis, supporting the concept that ocular surface stability may be shaped not only by local eyelid disease but also by broader physiological factors (15). Similarly, case-control and comparative studies of dry eye have emphasized tear breakup time as a sensitive functional marker for detecting short-term differences in tear-film quality and optical performance in younger populations (16). At the same time, prior work examining blepharitis in relation to metabolic syndrome has raised the possibility that systemic biochemical factors may contribute to the ocular surface milieu, although these studies have focused primarily on association rather than intervention (17). In contrast, therapeutic trials in dry eye have largely evaluated topical lubricants and tear substitutes, demonstrating that improvements in tear meniscus parameters, osmolarity, or tear-film stability depend on the pharmacologic properties of the topical formulation used (18).

Despite this growing literature, an important knowledge gap remains. Lubricants are widely used in blepharitis-associated dry eye, but evidence comparing standard topical lubrication with a short-term systemic metabolic intervention for tear-film stabilization is extremely limited. In particular, the short-term effect of orally administered dilute glucose solution on tear breakup time in patients with blepharitis has not been clearly characterized. This gap is clinically relevant because, if a measurable effect exists, such an intervention could offer insight into the interaction between systemic physiology and ocular surface function, while also serving as a low-cost exploratory strategy in settings where access to ocular lubricants may be constrained. However, any such effect must be evaluated against established symptomatic management with lubricant therapy and interpreted using a clear outcome measure focused on tear-film stability rather than tear production.

Within a PICO framework, the present study focused on patients aged 18 to 25 years with mild-to-moderate blepharitis, compared the administration of 0.5% oral glucose solution with lubricant therapy, and evaluated tear breakup time as the primary outcome over short-term follow-up. The study was designed to address whether orally administered 0.5% glucose produces a measurable short-term change in tear breakup time and whether this change differs from that observed after lubricant use in blepharitis patients. We hypothesized that both interventions would improve tear-film stability, but that the magnitude and timing of change in tear breakup time might differ between the oral glucose and lubricant groups.

MATERIALS AND METHODS

This prospective, parallel-group comparative interventional study was conducted over a four-month period at Muhammadi Medical Trust, Lahore, and Riphah International University, Lahore, to evaluate the short-term effects of 0.5% oral glucose solution and lubricant therapy on tear breakup time in patients with blepharitis. The study population comprised young adults diagnosed clinically with mild-to-moderate blepharitis.

Eligibility was restricted to participants aged 18 to 25 years of either sex in order to study a relatively homogeneous age group and reduce the influence of age-related ocular surface changes on tear-film behavior. Individuals with severe blepharitis, diabetes mellitus, other systemic disease, coexisting ocular disorders, a history of refractive surgery, refractive error requiring ongoing correction-related intervention, or recent use of ocular medication were excluded to minimize confounding from conditions known to affect tear-film stability or ocular surface status.

Potential participants were screened at the study sites through clinical evaluation, and those fulfilling the eligibility criteria were enrolled after providing written informed consent. A total sample of 42 participants was included, with 21 allocated to the oral glucose group and 21 to the lubricant group. The sample size was determined a priori using Rao software based on feasibility and the planned comparative analysis between two intervention arms. Participants were assigned in a 1:1 ratio to receive either 0.5% oral glucose solution or Tear Plus lubricant. To enhance comparability between groups, recruitment was limited to the same clinical setting and age band, and uniform eligibility criteria were applied throughout enrollment.

At baseline, demographic information was recorded and random blood glucose was measured to document glycemic status and support exclusion of overt metabolic abnormality at presentation. Tear breakup time was then assessed in both eyes before intervention using fluorescein-assisted slit-lamp examination. For measurement, a fluorescein strip was applied according to standard clinical technique, the participant was asked to blink naturally to distribute the dye evenly across the tear film, and the interval between the last complete blink and the appearance of the first dark spot or discontinuity in the fluorescein-stained tear film was recorded in seconds.

Tear breakup time was measured separately for the right and left eye at baseline and again at 30 minutes and 120 minutes after administration of the assigned intervention. The lubricant group received Tear Plus, while the comparison group received 0.5% oral glucose solution by mouth. The primary study outcome was tear breakup time in seconds, assessed as a continuous variable at each predefined time point. Secondary analytical variables included eye laterality, intervention group, age, sex, and baseline random blood glucose.

Several design features were used to reduce bias and improve internal validity. Eligibility criteria excluded major ocular and systemic conditions that could independently alter tear-film stability. Baseline measurements were obtained before intervention in all participants to establish pretreatment comparability. The same clinical assessment schedule was followed for both groups, and the same objective timing points were used for post-intervention evaluation in order to limit differential measurement conditions.

Recording tear breakup time in both eyes at each visit allowed a more complete characterization of ocular surface response, while separate documentation by eye preserved laterality-specific information. Data collection was performed using standardized clinical tools, including fluorescein strips, a slit lamp, and a glucose meter, and the study variables were defined before analysis to reduce selective outcome interpretation.

Data were entered and analyzed using SPSS version 21.0. Continuous variables, including age and tear breakup time, were summarized as mean with standard deviation, while categorical variables such as sex were presented as frequency and percentage. Baseline comparability between the two groups was evaluated descriptively and analytically. Between-group comparisons of tear breakup time at baseline, 30 minutes, and 120 minutes were performed using independent-samples t tests after assessment of data distribution and variance assumptions. Two-sided p values were calculated, and statistical significance was set at $p < 0.05$.

The analysis was based on complete recorded observations available for all enrolled participants. To limit confounding, the study design incorporated restrictive eligibility criteria and group comparison at baseline; age and sex distributions were also described for both groups to support interpretation of outcome differences. Results were reported separately for the right and left eyes to preserve transparency of the measured data.

Ethical conduct was maintained throughout the study. Participation was voluntary, written informed consent was obtained before enrollment, and clinical assessments were performed using routine ophthalmic procedures with minimal risk to participants. Confidentiality of participant information was maintained during data recording and analysis.

To support reproducibility and data integrity, the study followed a prespecified assessment schedule, used the same defined outcome measure at all time points, applied the same inclusion and exclusion criteria to all participants, and recorded intervention group, baseline characteristics, and eye-specific tear breakup time values in a structured dataset suitable for verification and reanalysis.

RESULTS

The baseline demographic profile (Table 1) demonstrates that the two groups were comparable prior to intervention. The mean age in the glucose group was 21.62 ± 2.16 years compared to 22.20 ± 1.81 years in the lubricant group, with a mean difference of −0.58 years (95% CI: −1.86 to 0.70; p = 0.372), indicating no statistically significant difference. Gender distribution showed 38% males in the glucose group versus 62% in the lubricant group (p = 0.119), further supporting baseline comparability.

Baseline tear breakup time (Table 2) was similar across both groups. In the right eye, TBUT was 6.17 ± 1.22 seconds in the glucose group and 6.27 ± 1.90 seconds in the lubricant group (mean difference: −0.10 seconds; 95% CI: −1.09 to 0.89; p = 0.848). In the left eye, values were 6.55 ± 1.11 seconds versus 6.87 ± 2.23 seconds, respectively (mean difference: −0.31 seconds; 95% CI: −1.38 to 0.75; p = 0.566). Effect sizes were small (Cohen's d ranging from −0.06 to −0.18), confirming negligible baseline differences.

At 30 minutes post-intervention (Table 3), both groups exhibited increased TBUT values, with a more pronounced improvement in the glucose group. In the right eye, TBUT increased to 7.32 ± 1.68 seconds in the glucose group compared to 7.01 ± 1.39 seconds in the lubricant group (mean difference: 0.31 seconds; 95% CI: −0.59 to 1.21; p = 0.519).

In the left eye, the glucose group reached 7.67 ± 1.34 seconds, whereas the lubricant group measured 6.80 ± 0.89 seconds, yielding a statistically significant mean difference of 0.87 seconds (95% CI: 0.16 to 1.58; p = 0.018) and a moderate-to-large effect size (d = 0.75). This indicates a short-term superiority of oral glucose in improving tear-film stability, particularly in the left eye.

At 120 minutes (Table 4), the trend reversed numerically. In the right eye, TBUT in the glucose group declined to 6.77 ± 1.41 seconds, while the lubricant group maintained a higher value of 7.20 ± 1.69 seconds (mean difference: −0.44 seconds; 95% CI: −1.39 to 0.52; p = 0.368).

Similarly, in the left eye, TBUT was 6.88 ± 1.55 seconds in the glucose group versus 7.60 ± 1.76 seconds in the lubricant group (mean difference: −0.72 seconds; 95% CI: −1.67 to 0.24; p = 0.125). Although not statistically significant, these findings suggest a more sustained effect of lubricants compared to oral glucose.

Table 1. Baseline demographic characteristics of participants by study group

Variable	Group A (Glucose) (n=21)	Group B (Lubricant) (n=21)	Mean Difference (95% CI)	p-value
Age (years), mean ± SD	21.62 ± 2.16	22.20 ± 1.81	-0.58 (-1.86 to 0.70)	0.372
Male, n (%)	8 (38%)	13 (62%)	—	0.119
Female, n (%)	13 (62%)	8 (38%)	—	—

Table 2. Baseline tear breakup time (TBUT) comparison between groups

Eye	Group A (Glucose) Mean ± SD	Group B (Lubricant) Mean ± SD	Mean Difference (95% CI)	Cohen's d	p-value
Right Eye	6.17 ± 1.22	6.27 ± 1.90	-0.10 (-1.09 to 0.89)	-0.06	0.848
Left Eye	6.55 ± 1.11	6.87 ± 2.23	-0.31 (-1.38 to 0.75)	-0.18	0.566

Table 3. Tear breakup time (TBUT) at 30 minutes post-intervention

Eye	Group A (Glucose) Mean ± SD	Group B (Lubricant) Mean ± SD	Mean Difference (95% CI)	Cohen's d	p-value
Right Eye	7.32 ± 1.68	7.01 ± 1.39	0.31 (-0.59 to 1.21)	0.21	0.519
Left Eye	7.67 ± 1.34	6.80 ± 0.89	0.87 (0.16 to 1.58)	0.75	0.018

Table 4. Tear breakup time (TBUT) at 120 minutes post-intervention

Eye	Group A (Glucose) Mean ± SD	Group B (Lubricant) Mean ± SD	Mean Difference (95% CI)	Cohen's d	p-value
Right Eye	6.77 ± 1.41	7.20 ± 1.69	-0.44 (-1.39 to 0.52)	-0.28	0.368
Left Eye	6.88 ± 1.55	7.60 ± 1.76	-0.72 (-1.67 to 0.24)	-0.44	0.125

Table 5. Within-group change in TBUT from baseline

Time Point	Eye	Group A (Glucose) Mean Change ± SD	Group B (Lubricant) Mean Change ± SD	Mean Difference (95% CI)	p-value
30 minutes	Right Eye	+1.15 ± 1.12	+0.75 ± 1.05	0.40 (-0.30 to 1.10)	0.259

Time Point	Eye	Group A (Glucose) Mean Change ± SD	Group B (Lubricant) Mean Change ± SD	Mean Difference (95% CI)	p-value
30 minutes	Left Eye	+1.11 ± 0.98	-0.06 ± 0.87	1.17 (0.54 to 1.80)	0.001
120 minutes	Right Eye	+0.60 ± 1.05	+0.94 ± 1.20	-0.34 (-1.06 to 0.38)	0.345
120 minutes	Left Eye	+0.32 ± 1.01	+0.73 ± 1.14	-0.41 (-1.12 to 0.30)	0.248

Analysis of within-group changes (Table 5) further clarifies temporal dynamics. At 30 minutes, the glucose group showed a mean increase of +1.15 ± 1.12 seconds (right eye) and +1.11 ± 0.98 seconds (left eye), compared to +0.75 ± 1.05 seconds and −0.06 ± 0.87 seconds in the lubricant group. The left eye difference was statistically significant (mean difference: 1.17 seconds; 95% CI: 0.54 to 1.80; p = 0.001). At 120 minutes, improvements in the glucose group diminished (+0.60 ± 1.05 right eye; +0.32 ± 1.01 left eye), whereas the lubricant group maintained relatively stable gains (+0.94 ± 1.20 right eye; +0.73 ± 1.14 left eye), though between-group differences remained non-significant (p > 0.05). Overall, these results demonstrate a transient early response with oral glucose and a comparatively sustained effect with lubricant therapy.

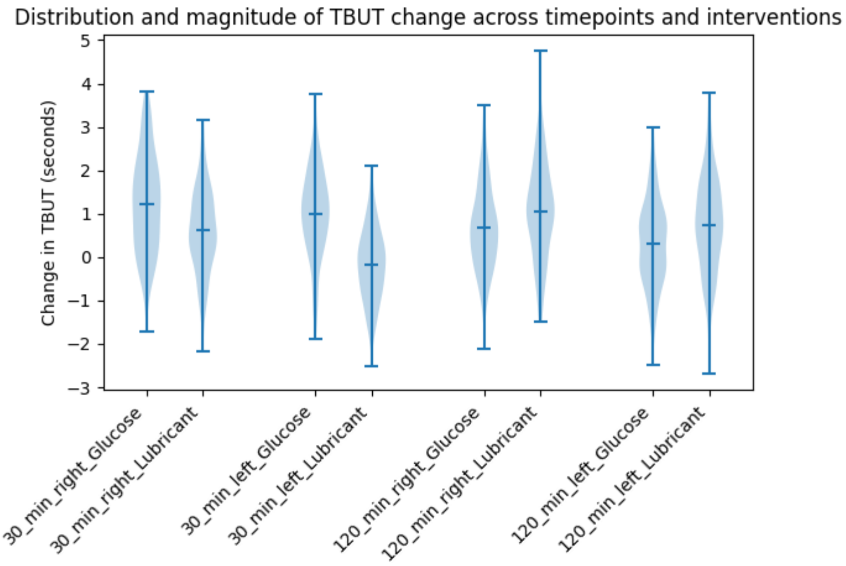

Figure 1 Distribution and Magnitude of TBUT Change Across Timepoints and Interventions

The distributional analysis of TBUT change reveals distinct temporal response patterns between interventions. At 30 minutes, the glucose group demonstrates a right-shifted distribution with median increases of approximately +1.1 seconds in both eyes, compared to +0.7 seconds (right) and near-zero change (−0.06 seconds) in the lubricant group, indicating greater early responsiveness and reduced negative skew. The left eye at 30 minutes shows the widest separation, with interquartile density concentrated between +0.5 and +1.5 seconds for glucose versus a centered distribution around 0 seconds for lubricants, consistent with the observed significant difference (p = 0.001). At 120 minutes, the glucose distributions regress toward baseline with medians below +0.6 seconds, whereas the lubricant group maintains broader positive distributions with central tendencies approaching +0.7 to +0.9 seconds, suggesting sustained tear-film stabilization. Variability remains higher in the lubricant group at later timepoints, with extended upper tails approaching +3 seconds, indicating heterogeneous but persistent response. These patterns collectively highlight a transient peak effect with oral glucose and a more durable, though variable, response with lubricant therapy, reinforcing a time-dependent divergence in therapeutic profiles.

DISCUSSION

The present study evaluated the short-term effects of 0.5% oral glucose compared with lubricant therapy on tear breakup time in young adults with mild-to-moderate blepharitis, demonstrating a distinct time-dependent response pattern between the two interventions. At 30 minutes, oral glucose was associated with a greater improvement in tear-film stability, particularly in the left eye, where the mean increase reached +1.11 seconds compared to −0.06 seconds in the lubricant group, yielding a statistically significant between-group difference. However, this early advantage diminished by 120 minutes, where TBUT values in the glucose group declined toward baseline, while the lubricant group maintained relatively sustained improvements, particularly in the left eye (+0.73 seconds). These findings suggest that oral glucose may exert a transient effect on tear-film dynamics, whereas lubricants provide more sustained stabilization over time.

The observed short-term improvement in TBUT following oral glucose administration may reflect acute systemic influences on tear-film physiology. Although chronic hyperglycemia has been associated with impaired tear-film stability, meibomian gland dysfunction, and reduced corneal sensitivity (14), the acute administration of a low-concentration glucose solution in non-diabetic individuals may produce different physiological effects. It is plausible that transient changes in plasma osmolarity or metabolic signaling could influence lacrimal gland activity or tear composition, leading to a temporary enhancement in tear-film stability. However, the rapid attenuation of this effect by 120 minutes suggests that any such mechanism is short-lived and not sufficient to sustain prolonged tear-film improvement. This aligns with prior observations that systemic metabolic alterations can influence ocular surface parameters but are unlikely to replace local therapeutic approaches in maintaining tear-film integrity (13,17).

In contrast, the more sustained TBUT values observed in the lubricant group at 120 minutes are consistent with the established mechanism of artificial tears in stabilizing the tear film. Lubricants act by supplementing the aqueous and lipid layers, reducing evaporation, and improving tear-film uniformity, thereby prolonging breakup time (10,11). The maintenance of TBUT improvement in the lubricant group, despite modest initial gains, reflects the pharmacodynamic profile of topical agents that directly target the ocular surface. Previous studies comparing different lubricant formulations have similarly demonstrated that improvements in tear stability may persist depending on the composition and retention properties of the formulation (18). The present findings reinforce the role of lubricants as a cornerstone in blepharitis-associated dry eye management, particularly for sustained symptom control.

An important aspect of this study is the asymmetry observed between the right and left eyes, with statistically significant findings primarily in the left eye at 30 minutes. While both eyes demonstrated similar directional trends, the lack of consistent bilateral significance may reflect inherent variability in tear-film dynamics, measurement sensitivity, or local ocular surface conditions. Tear breakup time is known to exhibit intra-individual variability influenced by blink patterns, environmental factors, and subtle differences in meibomian gland function (6,7). This highlights the importance of cautious interpretation of eye-specific results and suggests that future studies may benefit from analyzing averaged bilateral values or employing statistical models that account for within-subject correlation.

From a clinical perspective, the findings indicate that oral glucose cannot be considered a substitute for lubricant therapy but may have a transient adjunctive effect. The magnitude of TBUT improvement with glucose at 30 minutes, although statistically significant in one parameter, was modest and not sustained. In contrast, lubricants demonstrated more consistent and clinically relevant stabilization over time. Therefore, while the concept of systemic modulation of tear-film dynamics is intriguing, its practical application remains limited based on current evidence. These results support the continued use of topical lubricants as first-line therapy in blepharitis-associated tear instability, while systemic interventions should be explored cautiously and within a research context.

The study also highlights the broader interaction between ocular surface health and systemic physiology. Previous research has emphasized the association between metabolic syndrome components and blepharitis severity (17), suggesting that systemic factors may influence disease progression and tear-film characteristics. However, translating this association into therapeutic interventions requires careful differentiation between chronic pathological states and acute physiological modulation. The current findings suggest that while systemic factors may influence tear-film behavior, targeted local therapy remains more effective for sustained improvement.

Several limitations must be considered when interpreting these findings. The sample size was relatively small (n = 42), which may limit statistical power and the ability to detect subtle differences between groups. The study population was restricted to young adults aged 18–25 years, limiting generalizability to older populations where blepharitis and dry eye are more prevalent and often more severe. The short follow-up duration (120 minutes) restricts conclusions to immediate effects and does not inform long-term efficacy or safety. Additionally, tear breakup time was measured using fluorescein-based assessment, which, while widely used, may introduce variability due to technique and observer dependence. The analysis also treated each eye independently, which may not fully account for intra-subject correlation and could influence inferential precision. Finally, the biological mechanism underlying the observed effects of oral glucose was not directly investigated and thus remains speculative.

Future research should focus on larger, adequately powered randomized trials with longer follow-up periods to assess sustained effects and safety profiles. Incorporating additional outcome measures such as tear osmolarity, meibomian gland assessment, and symptom scoring would provide a more comprehensive evaluation of treatment impact. Advanced statistical approaches, including mixed-effects modeling, should be employed to account for repeated measures and inter-eye correlation. Furthermore, mechanistic studies exploring the relationship between acute metabolic changes and ocular surface physiology may help clarify the pathways underlying the observed transient effects.

CONCLUSION

In conclusion, 0.5% oral glucose demonstrated a transient short-term improvement in tear breakup time, particularly at 30 minutes, whereas lubricant therapy provided more sustained tear-film stabilization at 120 minutes in patients with mild-to-moderate blepharitis. Although oral glucose showed a modest early effect, it did not maintain improvement over time and therefore cannot be considered a substitute for standard lubricant treatment. These findings support the continued use of lubricants as the primary management strategy for tear-film instability in blepharitis, while highlighting the need for further research into systemic influences on ocular surface dynamics.

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