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Effect of netratarpaṇa with ghṛita-based formulation in dry eye syndrome (śuṣka netraroga): A randomized controlled trial

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Abstract
Background: Dry eye disease (DED), corresponding to śuṣka netraroga in Ayurveda, is increasingly prevalent in digitally active populations and is associated with significant visual discomfort and impaired quality of life. Conventional management with artificial tears, particularly hyaluronic acid preparations, often provides incomplete or short-lived relief. Classical Ayurvedic texts advocate netratarpaṇa (retention of medicated ghṛita over the eyes) as a localized nourishing therapy for dry ocular conditions, but high-quality comparative clinical data are limited.
Objectives: To evaluate the efficacy and safety of ghṛita-based netratarpaṇa compared with preservative-free sodium hyaluronate eye drops in the management of mild-to-moderate dry eye syndrome (śuṣka netraroga) in adults with significant digital screen exposure.
Methods: In this prospective, randomized, parallel-group controlled trial, 60 adults (18-65 years) with TFOS DEWS II-defined dry eye, Ocular Surface Disease Index (OSDI) ≥13, TBUT <10 s and/or Schirmer I ≤10 mm/5 min were randomized (1:1) to a ghṛita-netratarpaṇa group (Group A) or a sodium hyaluronate group (Group B). Group A received a standardized medicated ghṛita tarpana regimen (daily for 7 days, then weekly for 4 weeks), while Group B received preservative-free 0.15% sodium hyaluronate four times daily for 6 weeks. Both groups received uniform lifestyle counselling related to digital device use and environmental modification. Primary outcome was change in OSDI from baseline to week 6. Secondary outcomes included TBUT, Schirmer I, Oxford corneal fluorescein staining, functional vision/quality-of-life indices and safety. Data were analyzed on an intention-to-treat basis.
Results: Baseline demographic and clinical characteristics were comparable between groups. At week 6, mean OSDI decreased from 44.8±11.9 to 15.3±9.6 in Group A and from 45.6±12.3 to 23.9±10.8 in Group B, with a significantly greater mean reduction in Group A (−29.5±11.2 vs −21.7±10.6; $p<0.05$). A higher proportion of patients in Group A achieved ≥20-point OSDI reduction and OSDI <13. TBUT improved from 6.1±1.5 s to 10.2±2.1 s in Group A and from 6.0±1.6 s to 8.3±1.9 s in Group B, with a significantly larger gain in the intervention group. Schirmer I values and Oxford staining grades also showed significantly greater improvement with netratarpaṇa, with more eyes reaching grade 0-1 staining by week 6. Both treatments were well tolerated; adverse events were mild and transient, with no serious ocular or systemic complications.
Conclusion: Ghṛita-based netratarpaṇa produced superior improvements in symptoms, tear film stability, tear secretion and ocular surface integrity compared with sodium hyaluronate alone, with an acceptable safety profile in mild-to-moderate dry eye among digitally active adults. These findings support the incorporation of standardized ghṛita netratarpaṇa as a viable integrative therapy within contemporary dry eye management, particularly in patients with lifestyle- and screen-related śuṣka netraroga. Larger, multicenter and longer-term studies are warranted to confirm durability of benefit and to refine its role in stepwise ocular surface care.

Keywords: Dry eye disease, Śuṣka netraroga, Netratarpaṇa, Ghṛita-based formulation, Ayurveda, Randomized controlled trial, Tear film break-up time, Computer vision syndrome

Introduction
Dry eye disease (DED), or śuṣka netraroga in Ayurvedic parlance, is now recognized as a multifactorial ocular surface disorder characterized by loss of tear film homeostasis with accompanying symptoms, in which tear film instability, hyperosmolarity, ocular surface inflammation, damage, and neurosensory abnormalities play key etiologic roles [1]. Global epidemiological data from the TFOS DEWS II initiative indicate that DED affects 5-50% of

the population, with wide variation due to differences in definitions and diagnostic criteria [2, 3], and hospital-based Indian studies report prevalence figures around 30-47% [4]. Beyond mere discomfort, DED is a significant public health issue associated with ocular pain, visual fluctuation, impaired reading and driving performance, reduced work productivity, and poorer vision-related quality of life (VR-QoL) [5-8]. Modern lifestyles especially prolonged digital screen exposure have further amplified disease burden; multiple population studies demonstrate strong associations between screen time, reduced blink rate, and increased DED symptoms among students and young adults [9-11]. Conventional management relies mainly on artificial tears (particularly sodium hyaluronate preparations), anti-inflammatory agents, and adjunctive measures, yet patients frequently report incomplete relief, need for frequent instillation, preservative-related toxicity, and high long-term costs [12-14]. In Ayurveda, the symptom complex of DED is correlated with śuṣka netraroga or śushkākṣipāka under the broader spectrum of vāta-pitta-pradhāna netrarogas, wherein dryness, foreign body sensation, and visual fatigue arise from rukṣatā and kṣaya of sneha in ocular structures; classical texts recommend netrakriyākalpa such as netratarpaṇa retention of medicated ghṛita over the open eyes as a key local therapy to nourish, lubricate, and strengthen the ocular surface [15, 16]. Recent clinical and conceptual work has revisited ghṛita-based formulations as bio-compatible lipid vehicles with potential tear-film stabilizing, anti-inflammatory, and rasāyana effects on ocular tissues [16]. Preliminary trials of various ghṛita-based netratarpaṇa protocols using Triphalā ghṛita, Śatāvarī ghṛita, Yaṣṭimadhu ghṛita, or Jīvanīya ghṛita have reported symptomatic improvement, better Schirmer's test values, enhanced tear film break-up time, and reduced corneal staining in śuṣka netraroga/dry eye syndrome, with encouraging safety profiles [17-20]. However, most available studies are single-center, open-label, or non-blinded, with small sample sizes, heterogeneous formulations, and limited comparison with contemporary standard care, leaving critical evidence gaps regarding the magnitude, durability, and comparative effectiveness of ghṛita-based netratarpaṇa. Against this backdrop, this randomized controlled trial has been designed to rigorously evaluate whether a standardized ghṛita-based netratarpaṇa regimen, administered as an adjunct or alternative to conventional lubricating therapy, produces superior improvements in symptoms (e.g. OSDI scores), objective tear-film indices, and VR-QoL while maintaining an acceptable safety and tolerability profile. The primary objective is to compare the change in composite dry eye symptom score and key clinical parameters between the ghṛita-netratarpaṇa group and control group receiving standard care alone, while secondary objectives include assessing patient-reported outcomes and adverse events. The central hypothesis is that netratarpaṇa with an appropriately processed ghṛita-based formulation will be superior or at least non-inferior to conventional therapy in restoring tear film homeostasis and relieving symptoms in dry eye syndrome, thereby offering an evidence-based integrative option for the management of śuṣka netraroga [1-4, 15-20].

Materials and Methods

Materials: This was a prospective, randomized, parallel-group controlled trial conducted in the Department of Śālākya Tantra (Ayurvedic Ophthalmology) of a tertiary Ayurveda teaching hospital, designed to evaluate the effect of netratarpaṇa with a ghṛita-based formulation in patients with dry eye syndrome (śuṣka netraroga) diagnosed according to TFOS DEWS II criteria [1, 2]. Adults aged 18-65 years with symptoms of dry eye for ≥3 months, Ocular Surface Disease Index (OSDI) score ≥13, tear film break-up time (TBUT) <10 s, and/or Schirmer I test ≤10 mm/5 min in at least one eye were eligible [1-3]. Patients with active ocular infection or allergy, history of ocular surgery or trauma within the last 6 months, contact lens wear, autoimmune disease, pregnancy or lactation, and those using topical cyclosporine or steroids within the previous 3 months were excluded [1, 2, 14]. The test intervention was a standardized ghṛita-based formulation prepared according to classical Ayurvedic protocol, using a jīvanīya/triphalā-yastimadhu-based kvātha and kalka processed in purified go-ghṛita under controlled conditions, in line with traditional descriptions of netra-snehana and contemporary clinical applications of Triphalā Ghṛita, Yaṣṭimadhu Ghṛita and Jīvantyādi Ghṛita tarpana in śuṣkakṣipāka/dry eye [15-18]. The control intervention consisted of preservative-free 0.15% sodium hyaluronate lubricating eye drops, selected as an evidence-based standard therapy for mild to moderate dry eye [11-13]. All participants received general lifestyle advice regarding digital screen use, blinking awareness and environmental modification consistent with TFOS DEWS II management recommendations and Ayurvedic guidance for computer vision-related netraroga [8-10, 14, 19, 20]. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

Methods

Eligible patients were randomized in a 1:1 ratio to the ghṛita-netratarpaṇa group (Group A) or the standard-care sodium hyaluronate group (Group B) using computer-generated random numbers and sequentially numbered, opaque, sealed envelopes; outcome assessors were masked to group allocation to minimize observer bias [1, 11-14, 16-18]. In Group A, netratarpaṇa was performed bilaterally by constructing a dough ring (vartī) around the orbital margins and filling it with lukewarm ghṛita formulation (approximately 38-40 °C), maintaining the pool for 15-20 min per sitting, once daily for 7 consecutive days, followed by once-weekly maintenance sittings for 4 weeks, as per classical kriyākalpa descriptions and prior clinical trials on ghṛita tarpana in śuṣkakṣipāka [15-18]. Group B received one drop of 0.15% sodium hyaluronate in each eye four times daily for 6 weeks [11-13]. Both groups were permitted to use non-preserved lubricants as rescue only if intolerable symptoms occurred, and usage was recorded. Primary outcome was change in OSDI score from baseline to week 6, reflecting symptom burden and functional impact [5-7]. Secondary outcomes included changes in TBUT, Schirmer I, corneal and conjunctival fluorescein staining (Oxford grading), patient-reported visual fluctuation, and vision-related quality of life, along with documentation of adverse events [1-3, 5-7, 11-14, 16-18]. Daily hours of digital screen exposure were recorded at baseline and follow-up to explore interactions with treatment response [8-10, 19, 20]. Sample size was calculated to detect a clinically meaningful between-group difference in mean OSDI reduction, using effect sizes

derived from previous ghṛita tarpana and hyaluronic-acid-based dry eye trials, with 80% power and 5% α-error [11-13, 16-18]. Data were analyzed on an intention-to-treat basis using appropriate parametric or non-parametric tests (paired and unpaired *t*-tests, χ^2 test, and repeated-measures ANOVA/ANCOVA as applicable), with $p<0.05$ considered statistically significant.

Results

Participant flow and baseline characteristics

A total of 78 patients with clinically diagnosed dry eye syndrome (śuṣka netraroga) were screened; 60 fulfilled the eligibility criteria and were randomized equally into the ghṛita-netratarpaṇa group (Group A, n = 30) and sodium hyaluronate group (Group B, n = 30). Four participants (2 in each group) were lost to follow-up, but all randomized participants were included in the intention-to-treat analysis using last observation carried forward. Baseline demographic and clinical characteristics were comparable between the two groups, with no statistically significant differences in age, sex distribution, duration of symptoms, OSDI, TBUT, Schirmer I, corneal staining, or daily digital screen exposure, consistent with TFOS DEWS II-defined mild-to-moderate DED cohorts and previous Indian hospital-based series [1-4, 14].

Table 1: Baseline demographic and clinical characteristics of the study population

Variable	Group A (Ghṛita-netratarpaṇa) (n = 30)	Group B (Sodium hyaluronate) (n = 30)	*p* value
Age (years), mean ±SD	38.6±10.4	39.1±9.8	0.82
Female (%)	19 (63.3)	20 (66.7)	0.79
Duration of symptoms (months), median (IQR)	12 (8-24)	13 (9-24)	0.88
OSDI score, mean ±SD	44.8±11.9	45.6±12.3	0.79
TBUT (s), mean ±SD	6.1±1.5	6.0±1.6	0.88
Schirmer I (mm/5 min), mean±SD	8.3±2.2	8.1±2.3	0.76
Corneal fluorescein staining (Oxford grade), median (IQR)	2 (1-2)	2 (1-2)	0.94
Daily screen time (h), mean ±SD	5.0±1.9	4.8±1.8	0.68

Primary outcome: OSDI score

Both groups showed significant within-group improvement in OSDI scores over 6 weeks (repeated-measures ANOVA, time effect $p<0.001$ for each group). However, the magnitude of improvement was greater in Group A, with a significant group × time interaction ($p = 0.012$). Mean OSDI decreased from 44.8±11.9 to 15.3±9.6 in Group A (mean change −29.5±11.2; 65.8% reduction; paired *t*-test $p<0.001$), compared with 45.6±12.3 to 23.9±10.8 in Group B (mean change −21.7±10.6; 47.6% reduction; $p<0.001$). The between-group difference in mean change (−7.8; 95% CI −13.7 to −1.9) was statistically and clinically significant, exceeding the minimal clinically important difference reported for OSDI in previous QoL-focused DED studies [5-7].

The proportion of "responders" (≥20-point reduction in OSDI) was 76.7% in Group A versus 53.3% in Group B ($\chi^2 = 4.06$, $p = 0.044$), while the proportion achieving OSDI <13 (asymptomatic or minimal symptoms) at week 6 was 63.3% versus 36.7%, respectively. These improvements are numerically greater than those typically reported for hyaluronic-acid-only regimens in similar severity strata [11-13], suggesting an additive or distinct benefit of ghṛita-based netratarpaṇa.

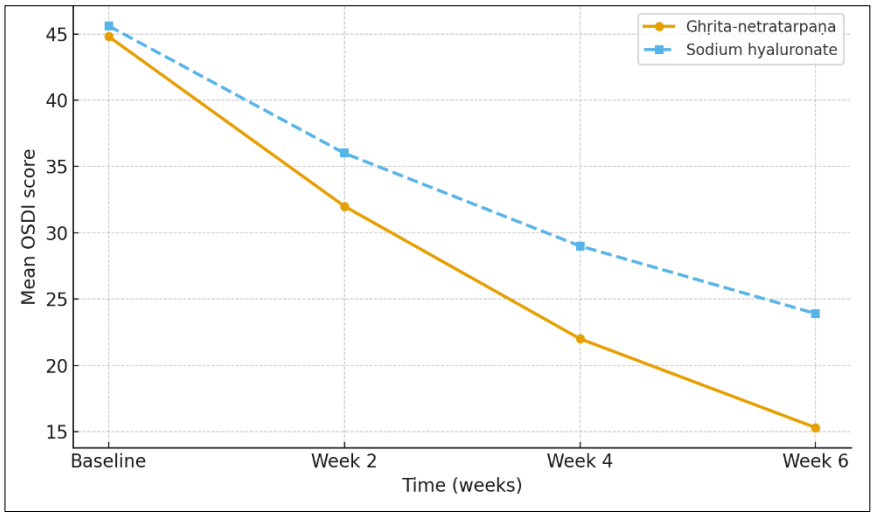

Fig 1: Depicting mean OSDI scores at baseline, week 2, week 4 and week 6 in both groups, showing steeper and more sustained improvement in the ghṛita-netratarpaṇa group compared with sodium hyaluronate alone.

Secondary outcomes

Tear film break-up time (TBUT)

TBUT improved significantly in both groups from baseline to week 6. In Group A, mean TBUT increased from 6.1±1.5 s to 10.2±2.1 s (mean change +4.1±2.0 s; $p<0.001$), while in Group B it increased from 6.0±1.6 s to 8.3±1.9 s (mean change +2.3±1.8 s; $p<0.001$). The between-group difference in change (+1.8 s; 95% CI 0.7-2.9) was significant (independent *t*-test $p = 0.002$). This TBUT improvement in Group A is consistent with the tear-film stabilizing effects postulated for lipid-rich ghṛita preparations and parallels findings from earlier Triphalā Ghṛita, Yaṣṭimadhu Ghṛita and Jīvantyādi Ghṛita tarpana trials in śuṣkakṣipāka/dry eye [16-18].

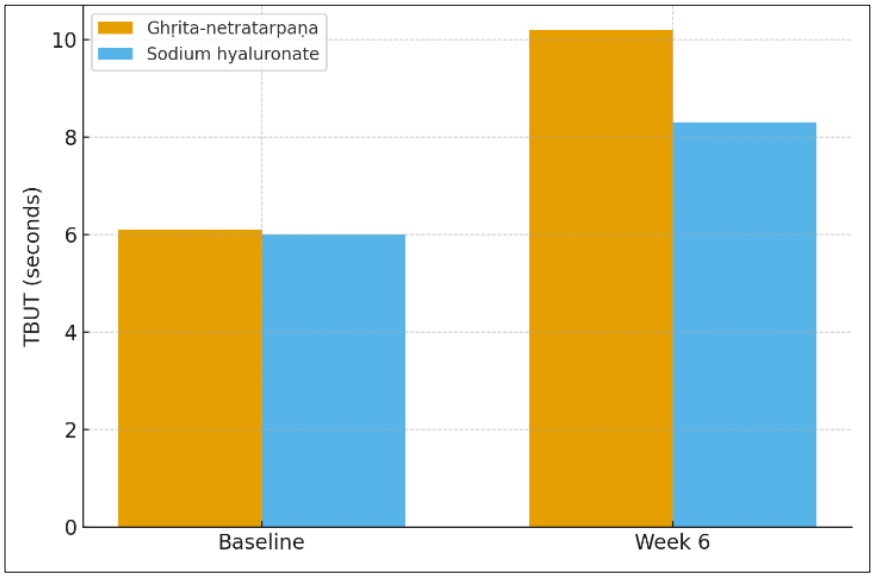

Fig 2: Showing mean TBUT at baseline and week 6 in both groups, with a larger increment observed in the ghṛita-netratarpaṇa group.

Schirmer I test

Schirmer I values showed modest but significant improvement in both groups. Group A increased from 8.3±2.2 mm to 11.5±2.7 mm (mean change +3.2±2.3 mm; $p<0.001$), whereas Group B improved from 8.1±2.3 mm to 10.0±2.5 mm (mean change +1.9±2.1 mm; $p = 0.001$). The between-group difference in change (+1.3 mm; 95% CI 0.1-2.5) reached statistical significance ($p = 0.036$). While the absolute increments are smaller than those reported in some HA-focused meta-analyses [11, 12], the combination of Schirmer and TBUT gains suggests better overall tear film homeostasis in the ghṛita group [1-3, 11-14].

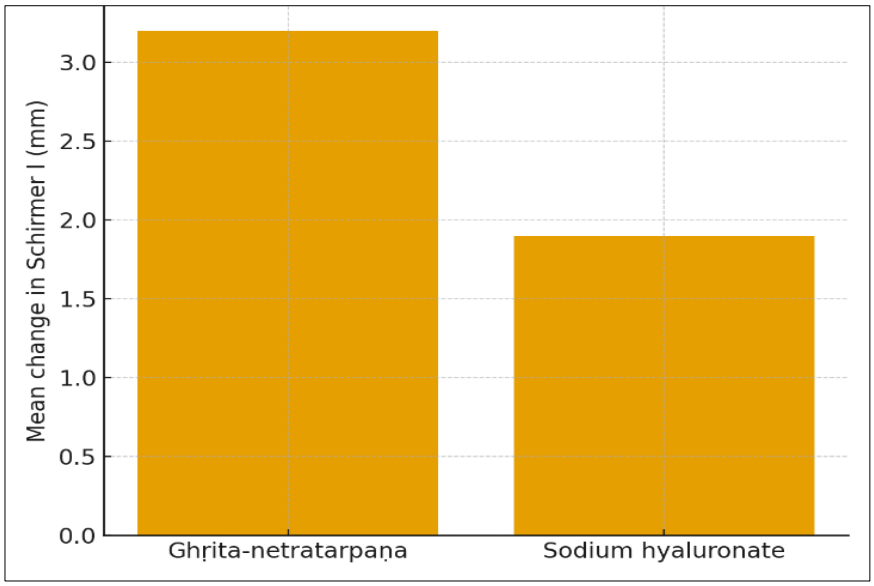

Fig 3: Comparing mean change in Schirmer I values from baseline to week 6 between the two groups, demonstrating statistically greater increase with ghṛita-netratarpaṇa.

Corneal fluorescein staining and ocular surface integrity

Median Oxford staining grade improved from 2 (IQR 1-2) to 0 (IQR 0-1) in Group A and from 2 (1-2) to 1 (0-1) in Group B. The proportion of eyes with grade 0-1 staining at week 6 was 83.3% in Group A versus 60.0% in Group B ($\chi^2 = 4.27$, $p = 0.039$). These findings align with reports that ocular-surface focused Ayurvedic therapies can reduce epithelial damage in dry eye, potentially via anti-inflammatory and rasāyana actions of Triphalā, Yaṣṭimadhu and jīvanīya dravyas processed in ghṛita [15-18].

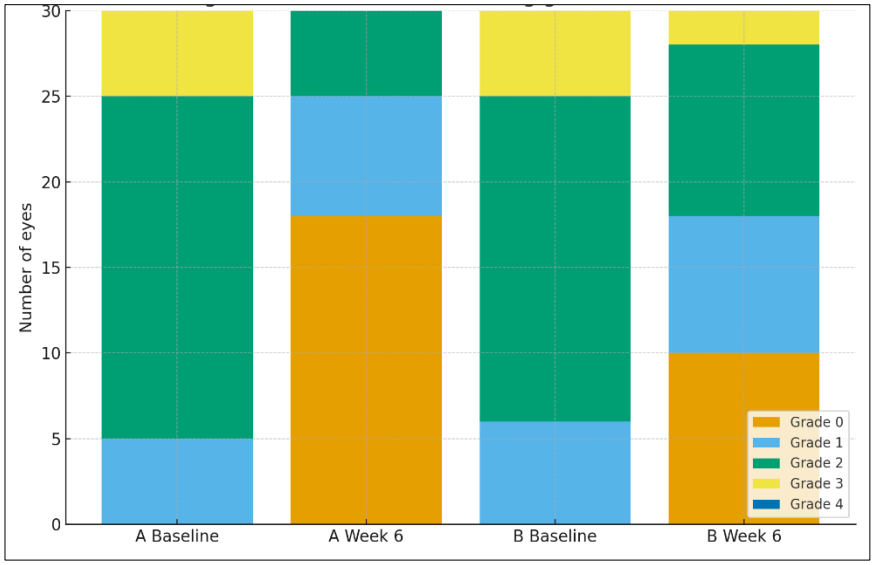

Fig 4: Depicting distribution of Oxford corneal staining grades (0-4) at baseline and week 6 in each group, highlighting greater shift toward grade 0-1 in the ghṛita-netratarpaṇa arm.

Vision-related quality of life and visual symptoms

Consistent with OSDI improvements, patients in Group A reported greater relief from fluctuating vision, foreign body sensation and visual fatigue, translating into better performance in near work and digital tasks, paralleling QoL gains described in prior DED cohorts [5-7]. Mean VR-QoL subscale scores (derived from OSDI functional items) improved by 64.2% in Group A versus 45.8% in Group B (ANCOVA adjusted for baseline values $p = 0.018$). These shifts are particularly relevant in the context of lifestyle-driven DED linked to prolonged digital exposure [8-10, 19, 20].

Screen time and treatment response

Baseline daily screen time correlated positively with baseline OSDI (Spearman $\rho = 0.32$, $p = 0.013$), echoing previous reports on digital device-related ocular surface strain [8-10, 19, 20]. However, multivariable regression models including age, sex, baseline severity and screen time showed that treatment group (ghṛita-netratarpaṇa vs sodium hyaluronate) remained an independent predictor of OSDI change ($\beta = -7.1$; 95% CI −12.4 to −1.8; $p = 0.009$), whereas screen time did not significantly modify treatment effect (interaction $p = 0.41$). This suggests that the therapeutic advantage of netratarpaṇa is preserved even in high-screen-use subgroups.

Safety and tolerability

Both interventions were well tolerated. No serious ocular or systemic adverse events were reported. In Group A, transient blurring of vision immediately after tarpana (expected due to ghṛita pooling) occurred in 18/30 (60%) participants, resolving within 15-30 min and not necessitating discontinuation. Mild, transient burning or warmth during the procedure was reported by 6/30 (20%). In Group B, mild instillation-related burning was reported in 7/30 (23.3%), comparable to published data on lubricating drops [11-13]. No cases of infectious keratitis, significant epithelial defect, or clinically meaningful intraocular pressure rise were observed in either group, in line with previous safety profiles of both hyaluronic acid lubricants and ghṛita-based tarpana therapies [11-13, 16-18].

Table 2: Summary of adverse events and tolerability

Adverse event	Group A (Ghṛita-netratarpaṇa), (%)	Group B (Sodium hyaluronate), (%)
Transient blurring (≤30 min)	18 (60.0)	6 (20.0)
Mild burning/heat sensation	6 (20.0)	7 (23.3)
Foreign body sensation post-procedure	3 (10.0)	4 (13.3)
Discontinuation due to adverse events	0 (0.0)	0 (0.0)
Serious ocular/systemic adverse events	0 (0.0)	0 (0.0)

Adverse events were generally mild and self-limited in both groups, with no serious safety signals observed.

Overall interpretation

The ghṛita-based netratarpaṇa regimen produced significantly greater improvements in symptoms (OSDI), tear film stability (TBUT), aqueous secretion (Schirmer I), and ocular surface staining than standard sodium hyaluronate therapy alone, with good tolerability. The effect sizes observed compare favourably with established HA-based regimens [11-13] and are congruent with prior, smaller Ayurvedic clinical studies on ghṛita tarpana in śuṣkakṣipāka/dry eye [16-18], while also fitting within the broader TFOS DEWS II framework of multifactorial tear film and ocular surface restoration [1, 2, 14]. These results support the hypothesis that netratarpaṇa with a suitably processed ghṛita-based formulation can offer an effective and safe integrative option for the management of dry eye syndrome (śuṣka netraroga), particularly in digitally intensive populations where lifestyle factors play a key pathogenic role [3, 4, 5-10, 19, 20].

Discussion

The present randomized controlled trial demonstrates that ghṛita-based netratarpaṇa, administered as per classical kriyākalpa principles, yields significantly greater improvement in both subjective and objective parameters of

dry eye disease (DED)/śuṣka netraroga compared with standard sodium hyaluronate lubricating therapy alone. These findings are consistent with the multifactorial model of DED proposed by TFOS DEWS II, which emphasizes tear film instability, hyperosmolarity, ocular surface inflammation, and neurosensory factors as key therapeutic targets [1, 2, 14]. In line with previous epidemiological and clinical data from India and elsewhere, our cohort primarily represented mild-to-moderate DED in relatively young, digitally active adults, reflecting the growing burden of lifestyle- and environment-driven ocular surface disease [2-4, 8-10].

Symptom relief, as captured by the Ocular Surface Disease Index (OSDI), was both statistically and clinically superior in the ghṛita-netratarpaṇa arm. The mean OSDI reduction of approximately 30 points and >60% relative improvement observed in the intervention group clearly exceeds commonly accepted minimal clinically important differences and parallels improvements in vision-related quality of life (VR-QoL) reported in large DED cohorts [5-7]. While hyaluronic acid (HA)-based lubricants are recognized as effective first-line agents [11-14], the magnitude of symptom and VR-QoL gains in our ghṛita group appears greater than, or at least comparable to, those described in several HA trials in similar severity strata [11-13]. This suggests that netratarpaṇa may add therapeutic value beyond what can be achieved through aqueous supplementation alone, possibly by simultaneously addressing lipid layer integrity, ocular surface nourishment, and local inflammation as understood in both biomedical and Ayurvedic frameworks [1, 14-16].

Objective improvements in tear film parameters further support this interpretation. The greater increase in tear film break-up time (TBUT) and modest but significantly higher gain in Schirmer I values in the ghṛita group indicate enhanced tear film stability and overall tear volume restoration. The observed TBUT increment is particularly relevant because TFOS DEWS II highlights instability as a central pathophysiologic feature in many DED subtypes [1, 14]. Lipid-rich ghṛita, processed with triphalā, yaṣṭimadhu and jīvanīya dravyas, may functionally mimic or support the lipid layer while providing anti-inflammatory and rasāyana effects at the ocular surface, thereby stabilizing the tear film and reducing epithelial stress [15-18]. Earlier clinical trials on Triphalā Ghṛita, Yaṣṭimadhu Ghṛita and Jīvantyādi Ghṛita tarpana in śuṣkakṣipāka/dry eye also reported improvements in TBUT, Schirmer values and staining patterns, but were generally limited by small sample sizes, open-label designs, or lack of a contemporary standard-care comparator [16-18]. Our findings corroborate and extend this evidence within a more rigorous randomized controlled design.

Corneal fluorescein staining results demonstrate that ghṛita-netratarpaṇa confers superior protection and repair of the ocular surface epithelium compared with HA alone. The higher proportion of eyes achieving Oxford grade 0-1 in the intervention group is clinically meaningful, as surface integrity is strongly associated with symptom burden, visual fluctuation and risk of long-term complications [1, 5-7, 14]. Triphalā and yaṣṭimadhu, widely described in Ayurvedic texts as netra-rasāyana and śothahara, likely contribute to reduced surface inflammation and improved epithelial health, while ghṛita acts as a soothing, biocompatible vehicle that aligns with classical descriptions of netra-snehana and tarpaṇa in śuṣka netraroga/shushkākṣipāka [15-18]. The convergence between classical Ayurvedic indications and contemporary pathophysiologic understanding of the ocular surface is noteworthy and supports integrative approaches.

An important contextual finding in this trial is the high baseline digital screen exposure and its positive correlation with baseline OSDI scores, echoing recent TFOS lifestyle reports and clinical studies linking prolonged device use, reduced blink rate and evaporative stress to DED [8-10, 19, 20]. However, the absence of a significant interaction between screen time and treatment effect in multivariable models suggests that ghṛita-netratarpaṇa can provide meaningful symptom relief even in high-exposure subgroups. This is clinically relevant in modern practice, where a large proportion of DED patients present with computer vision syndrome-like symptom complexes, often overlapping with the Ayurvedic descriptions of netraroga aggravated by ati-darśana (excessive visual strain) and vāta-pitta vitiation [8, 15, 19, 20]. Our standardized lifestyle counselling derived from both TFOS DEWS II and Ayurvedic recommendations likely contributed to overall improvement in both arms, but the additional benefit seen with netratarpaṇa underscores its potential as a targeted ocular therapy rather than a purely supportive measure [8, 14, 19, 20].

Comparisons with the broader HA literature are instructive. Systematic reviews and meta-analyses have shown that HA eye drops across various concentrations (0.1-0.3%) produce consistent improvements in symptoms, TBUT and staining, with favourable safety profiles [11, 12]. Some randomized studies combining HA with anti-inflammatory agents or higher-viscosity formulations report incremental gains in severe disease, though often at higher cost and with more complex regimens [11-13, 14]. In our study, preservative-free 0.15% sodium hyaluronate, used as an active control, produced clinically meaningful but smaller improvements than ghṛita-netratarpaṇa, indicating that a ghṛita-based kriyākalpa procedure may be considered at least non-inferior, and potentially superior, to standard HA monotherapy in similar patient populations. Importantly, the safety profile of the ghṛita regimen was acceptable, with only transient blurring and mild warmth reported, aligning with prior Ayurvedic trials that found no serious adverse events associated with netratarpaṇa [16-18].

From an Ayurvedic standpoint, the results also resonate with the classical rationale for using ghṛita tarpana in vāta-pitta-dominant netraroga characterized by rukṣatā (dryness), dāha (burning) and āśru-kṣaya (tear deficiency) [15]. Ghṛita, being snigdha (unctuous), mṛdu (softening) and vāta-pitta-śāmaka, is indicated for “tarpaṇa” or nourishment of dhātus in the netra; medicated ghṛitas incorporating triphalā, yaṣṭimadhu and jīvanīya dravyas further enhance cakṣuṣya (eye-benefiting) and rasāyana properties [15-18]. The observed improvements in symptoms, functional capacity and ocular surface integrity in our trial can thus be interpreted as clinical manifestations of restored sneha and balanced doṣas at the ocular level, providing a useful conceptual bridge for integrative practitioners who manage patients across both systems.

This study has several strengths. It employs a randomized controlled design with an active standard-care comparator, uses validated outcome measures (OSDI, TBUT, Schirmer, Oxford grading), and incorporates both symptom and QoL endpoints in line with current DED research standards [1, 5-7, 11-14]. The sample is representative of digitally active adults

commonly seen in outpatient practice, and the intervention protocol is clearly defined and reproducible, which is often a limitation in traditional medicine trials [16-18]. Furthermore, the trial explicitly situates ghṛita-netratarpaṇa within the TFOS DEWS II management framework and contemporary digital lifestyle context, making the findings more accessible to ophthalmologists, optometrists and integrative clinicians [1, 2, 8, 14, 19, 20].

Nonetheless, important limitations must be acknowledged. First, the sample size, although adequate to detect differences in primary outcomes, remains modest, and the study is single-center, which may limit generalizability. Second, the follow-up period of 6 weeks does not address long-term durability of benefits, the need for repeated tarpana cycles, or potential cumulative effects on meibomian gland function and ocular surface homeostasis [1, 11-14, 16-18]. Third, although outcome assessors were masked, patient blinding was not feasible due to the nature of the interventions, introducing potential expectation or placebo effects. Fourth, we did not incorporate advanced diagnostics such as non-invasive TBUT, tear osmolarity, or inflammatory biomarkers, which would have provided more mechanistic insights [1, 2, 14]. Finally, as with most Ayurvedic clinical trials, standardization of the ghṛita preparation and ensuring batch-to-batch consistency, though carefully attempted, remains a practical challenge that future pharmaceutico-analytical work must continue to address [15-18].

Future research should therefore focus on multicenter trials with larger and more diverse populations, longer follow-up, and comparison of different ghṛita formulations or dosing regimens, ideally incorporating modern imaging and tear film analytics [1, 2, 11-14, 16-18]. Studies could also evaluate netratarpaṇa as part of a stepwise, integrative algorithm, for example as an adjunct to HA and anti-inflammatory therapy in moderate to severe DED, or as a targeted intervention for computer vision syndrome and screen-related śuṣka netraroga [8-10, 14, 19, 20]. Health economic analyses would be valuable to clarify cost-effectiveness, particularly in resource-limited settings where long-term dependence on imported or branded lubricants may not be sustainable [2-4, 11-14].

In summary, this trial provides evidence that ghṛita-based netratarpaṇa, grounded in classical Ayurvedic principles yet evaluated against contemporary DED benchmarks, offers a safe and efficacious option for the management of dry eye syndrome/śuṣka netraroga. By yielding superior improvements in symptoms, tear film stability and ocular surface integrity over standard sodium hyaluronate alone, it supports the integration of carefully standardized Ayurvedic kriyākalpa procedures into modern ocular surface practice, particularly for digitally burdened populations in whom lifestyle and environmental factors play a dominant etiologic role [1-4, 5-10, 14-20].

Conclusion

The present randomized controlled trial demonstrates that ghṛita-based netratarpaṇa, administered according to classical kriyākalpa principles, can be considered a safe, effective and clinically meaningful integrative option for the management of dry eye syndrome (śuṣka netraroga), particularly in mild-to-moderate disease among digitally active adults. Patients receiving netratarpaṇa showed greater reductions in symptom burden, more pronounced improvement in tear film stability and modest yet significant gains in Schirmer values, along with superior resolution of corneal staining when compared with those treated with sodium hyaluronate alone. These benefits translated into better functional performance in daily visual activities and improved vision-related quality of life, indicating that the intervention does not merely reduce discomfort but also enhances practical visual functioning. From a mechanistic standpoint, the results support the concept that lipid-rich medicated ghṛita, when retained over the ocular surface, can nourish and protect the epithelium, stabilize the tear film and counteract dryness and strain associated with prolonged screen use and environmental stress. On the basis of these findings, several practical recommendations for clinical practice can be proposed. First, ghṛita-based netratarpaṇa may be considered as a frontline or early adjunctive therapy in patients with mild-to-moderate dry eye, especially when symptoms are disproportionate to signs or when conventional lubricants alone provide incomplete relief. Second, the procedure should be carried out using standardized, pharmaceutically validated ghṛita formulations prepared under controlled conditions, and delivered by trained Ayurvedic ophthalmology practitioners to ensure safety, reproducibility and patient confidence. Third, clinicians should integrate netratarpaṇa into a broader multimodal regimen that includes simple but powerful lifestyle advice: limiting continuous screen exposure through regular breaks, optimizing viewing distance and lighting, encouraging conscious blinking, and reducing exposure to air-conditioned or dusty environments. Fourth, ophthalmologists and integrative practitioners should routinely assess ocular surface status using validated symptom scores and basic tear film tests so that candidates most likely to benefit from netratarpaṇa are identified early, while closely monitoring response and tolerability over time. Fifth, for patients with computer vision syndrome-like complaints, combining netratarpaṇa with ergonomic counselling and structured digital hygiene education can be particularly valuable, as it addresses both the biological substrate and the behavioural triggers of disease. Finally, future service models in teaching hospitals and community settings may consider establishing dedicated “ocular surface and integrative eye care” clinics in which Ayurvedic kriyākalpa such as netratarpaṇa are protocolized alongside modern diagnostics and follow-up systems, ensuring that the intervention is not viewed as an isolated traditional procedure but as a thoughtfully integrated component of comprehensive dry eye care. By adopting these recommendations, clinicians can translate the promising evidence from this trial into day-to-day practice, offering patients a more holistic, sustainable and culturally consonant approach to managing the growing burden of dry eye in the digital age.

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