ANNALS OF MEDICINE
2025, VOL. 57, NO. 1, 2512123
https://doi.org/10.1080/07853890.2025.2512123

RESEARCH ARTICLE

OPEN ACCESS Check for updates

Comparison of clinical characteristics of neurogenic rosacea and erythematotelangiectatic rosacea: a cross-sectional observational study

Tingwei Liu[a#], Zhi Yin[a#], Meng Tao[a,b#], Xiaoqi Meng[a], Hui Zhong[c,d], Yang Xu[a] and Xiulan Sun[e]

[a]Department of Dermatology, The First Affiliated Hospital with Nanjing Medical University, Nanjing, China; [b]Department of Dermatology, Zigong Fourth People's Hospital, Zigong, China; [c]State Key Laboratory of Natural Medicines, China Pharmaceutical University, Nanjing, China; [d]School of Traditional Chinese Pharmacy, China Pharmaceutical University, Nanjing, China; [e]Department of Pharmacology, Jiangsu Key Laboratory of Neurodegeneration, Nanjing Medical University, Nanjing, China

ABSTRACT

Background: It remains controversial whether neurogenic rosacea (NR) is a distinctive subtype of rosacea, and no study has been conducted on the Chinese population. We compared the clinical characteristics of patients with NR and erythematotelangiectatic rosacea (ETR) and explored whether NR can be considered a distinctive rosacea subtype.

Materials and methods: Nineteen patients with NR and 73 with ETR were enrolled. A questionnaire survey combined with electronic medical records and VISIA® digital images was used to collect information on patients' baseline demographic and clinical characteristics.

Results: The patients in the NR group reported less facial pruritus (36.8%) and dry skin (31.6%) than those in the ETR group ($p < .05$). The incidence and scores of flushing symptom-related evaluation indices in the NR group were higher than those in the ETR group ($p < .05$). The efficacy of drug treatment in the NR group (38.9%) was lower than that in the ETR group (85.5%, $p < .05$).

Conclusions: There were few differences between ETR and NR in the Chinese population, with the exception of dryness and itching, though there was only a small sample size of NR in this study. NR may be referred to as ETR in patients with refractory erythema.

ARTICLE HISTORY
Received 26 November 2024
Revised 23 April 2025
Accepted 5 May 2025

KEYWORDS
Rosacea; neurogenic rosacea; erythematotelangiectatic rosacea; refractory rosacea; neuropsychiatric disorders

Introduction

Rosacea is a chronic recurrent inflammatory cutaneous disorder that mainly affects the central face and is caused by the dysfunction of cutaneous blood vessels, nerves and pilosebaceous unit. It presents with various combinations of cutaneous signs such as flushing, erythema, telangiectasia, oedema, papules, pustules, ocular lesions and rhinophyma. It was divided into four main subtypes by the National Rosacea Society in 2002, including erythematotelangiectatic rosacea (ETR), papulopustular rosacea (PPR), phymatous rosacea (PhR) and ocular rosacea (OR) [1]. Neurogenic rosacea (NR) is a new subtype initially proposed by Scharschmidt et al. [2]. The diagnostic criteria are as follows: obvious facial erythema that is refractory to conventional treatment and accompanied by obvious burning and tingling sensation, the severity of subjective symptoms such as burning and tingling in some patients is significantly higher than that of clinical signs, and neuropsychiatric drugs are often used to control them, with or without obvious neuropsychiatric complications (depression, obsessive-compulsive disorder, essential tremor and migraine). Since then, these diagnostic criteria have been applied in several studies [3–6]. Schwab et al. reported a significant dilation of blood and lymphatic vessels in cases of rosacea, as well as a significant increase in the number of mast cells and fibroblasts within the affected tissue. Sensory nerves were found to be closely associated with both blood vessels and mast cells, with a notable increase in their presence in ETR [7]. However, whether NR is a distinctive subtype of rosacea remains controversial, and no study has been conducted in the Chinese population. Therefore, this study aimed to compare the clinical characteristics of patients with NR with those of patients with ETR and explore whether NR is a special subtype independent of ETR.

CONTACT Yang Xu yangxu@njmu.edu.cn Department of Dermatology, The First Affiliated Hospital with Nanjing Medical University, No. 300 Guangzhou Road, Nanjing, Jiangsu Province 210029, People's Republic of China; Xiulan Sun xiulans@njmu.edu.cn Department of Pharmacology, Jiangsu Key Laboratory of Neurodegeneration, Nanjing Medical University, Nanjing, China
[#]These authors contributed equally to this work.

Materials and methods

This cross-sectional observational study was conducted at the Department of Dermatology at the First Affiliated Hospital with Nanjing Medical University between 7 October 2021 and 30 May 2023. Participants were recruited from an outpatient clinic following routine practice. Data collection included a questionnaire survey of patients with rosacea and a review of electronic medical records and digital images obtained from the VISIA®6.0 Skin Analysis System (Canfield Image Systems, Fairfield, NJ).

According to the literature [2–6], NR is diagnosed according to the following criteria: (1) diagnosis based on the criteria established by the ROSacea COnsensus (ROSCO) 2017 [8,9]; (2) presence of obvious facial erythema that is accompanied by obvious burning and tingling sensation, of which the severity of self-conscious symptoms such as burning and tingling is significantly higher than that of clinical signs; (3) refractory facial erythema to conventional treatment including antibiotics (comprising metronidazole, doxycycline and minocycline), oral isotretinoin and oral beta-blockers.

The inclusion criteria for the ETR subtype were persistent midfacial erythema, episodic flushing, with or without telangiectasia in individuals with rosacea who were not qualified for NR diagnosis [1]. As also mentioned in the guidelines, PPR, PhR and OR have often been observed combined with ETR. Therefore, these patients were not excluded from our study. In addition, the related clinical manifestation was also compared with that of NR. The diagnosis and classification of rosacea were made by two independent physicians. Patients with facial inflammatory skin diseases such as acne, contact dermatitis, seborrheic dermatitis and other facial skin diseases, and those who were pregnant, lactating, had liver or kidney insufficiency or were undergoing treatment with long-term topical glucocorticoids or retinoids were excluded from the study.

All participants signed written informed consents. This research was approved by the Research Ethics Committee of the First Affiliated Hospital with Nanjing Medical University (ethics number: 2021-SR-326), conforming to the Declaration of Helsinki requirements. All participants comprehended and willingly agreed to participate in the study, signing informed consent forms voluntarily. The informed consent had encompassed the following key points: (1) a comprehensive understanding of the potential risks and benefits associated with study participation; (2) medical records will be stored in hospitals, with authorized access granted to researchers, research authorities and ethics committees; (3) be aware of relevant data such as medical records and clinical pictures for publication of articles and non-profit academic conferences. Informed consent was obtained from the patient for publication of the clinical images (including Figure 1) in this research study. To maintain confidentiality, all data files and sensitive personal information were encrypted, password-protected and stored on a secure computer accessible solely to the study coordinators. No

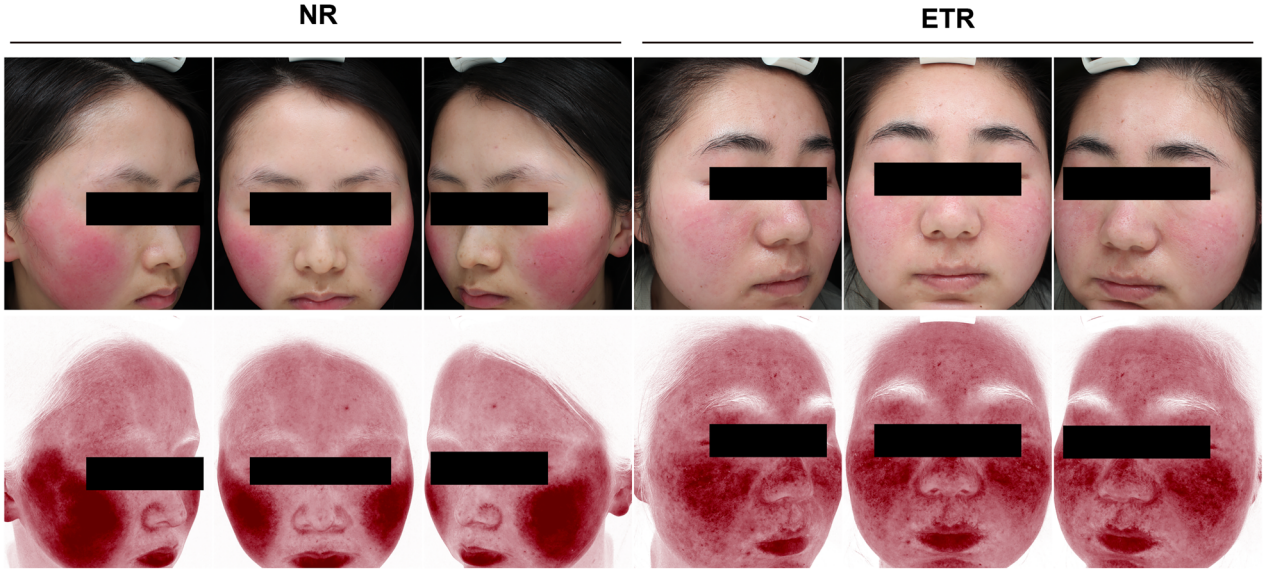

Figure 1. VISIA® Skin Analysis System shows the comparison of the white light area (top) and the red area (bottom) of patients with typical neurogenic and erythematotelangiectatic rosacea. Facial erythema of neurogenic rosacea is more likely to affect the lateral side of the cheek.

information that could link individuals to the data was disclosed.

The questionnaire was specifically designed to gather data on the progression of the condition, skin symptoms and potentially improper skin care practices, such as excessive use of facial cleansers (more than twice daily), facial masks (≥4 times weekly), frequent makeup application (≥6 times weekly), frequent skin care procedures at beauty salons (more than once weekly) or consistent daily use of commercially available skin care products without a State Drug Administration record number verification for >6 months, familial medical history, exacerbating or triggering factors, alleviating factors, systemic comorbidity, the impact of flushing on sleep patterns, scores for flushing-induced sleep disturbances, and overall flushing symptoms (including redness, warmth, tingling and/or itching) [10]. The Global Flushing Sleep Bothersome Score (GFSBS) and Global Flushing Symptom Score (GFSS) [10] were assessed using a 10-point scale, with higher scores indicating severe impact. According to the results of the Baumann Skin Type Indicator [11], the patients were divided into mixed dry and oily skins. Facial symptoms such as burning, swelling, stinging, itching and drying, as well as ocular symptoms (including dry, stinging and foreign object sensation), were reported by the patients. Facial signs including erythema, telangiectasia, papules, pustules, phymatous changes and midfacial erythema were diagnosed by physicians, among which midfacial erythema was physician-diagnosed according to images taken by VISIA®. Following the diagnosis of NR, a treatment regimen of anticonvulsants or antidepressants was initiated. Treatment efficacy was evaluated at the one-month follow-up by two dermatologists in both the NR group and the ETR group receiving conventional treatment. In the NR group and the ETR group, the treatment effect was evaluated at the one-month follow-up by two dermatologists who independently assessed the outcomes.

A reduction of two points or more in the GFSS score was defined as effective, whereas anything less than that reduction was considered ineffective or of minimal effect. Figure 2 shows the participant flow diagram.

Statistical analysis

Regarding continuous variables with normal distribution, the mean and standard deviation (SD) are reported, while for non-normally distributed continuous variables, the median and interquartile range (IQR) are presented. The Shapiro–Wilk test was used to check the normality of the data using IBM SPSS Statistics (version 26.0, Armonk, NY). Patient age, disease duration, flushing on sleep score, and overall flushing symptom score are non-normally distributed and expressed in median and percentiles. χ^2 and Fisher's tests were used to compare categorical variables. However, the Mann–Whitney *U*-test was used to compare between two groups. A two-tailed test was employed. Statistical significance was set at $p < .05$.

Results

Clinical features of NR and ETR

The NR group included 19 female patients aged 21–48 years (median: 26 years) with a disease duration ranging from 8 to 120 months (median: 24 months). All NR patients experienced a skin-burning sensation, with stinging, pruritus and dryness reported in seven (36.8%), seven (36.8%) and six (31.6%) cases, respectively (Table 1). Regarding comorbidities, anxiety was present in eight of NR patients, insomnia in five, migraine in three, and depression, gastritis, inflammatory bowel disease and hyperprolactinaemia in smaller percentages (Figure 3(A)).

The ETR group comprised 71 (97.3%) female participants aged 18–51 years (median: 28 years) with a disease duration between 3 and 276 months (median: 24 months). Facial burning was reported by 63 (86.3%) of ETR patients, stinging by 23 (31.5%), itching by 47 (64.4%) and dryness by 51 (69.9%). Itching and dryness were significantly more prevalent in ETR patients ($p < .05$) (Table 1).

A notable sex disparity was observed, with a higher proportion of females than males in both groups. Despite higher frequencies of facial burning, swelling, stinging and ocular symptoms in the NR group compared to the ETR group, no statistically significant difference was found between the two groups ($p > .05$). However, pruritus (36.8%) and dryness (31.6%) were significantly lower in the NR group, potentially due to the more pronounced symptoms of burning, tingling and swelling.

Positive family history prevalence was reported to be 4 in the NR group and 18 (24.7%) in the ETR group. Cooling interventions provided relief for facial symptoms in both groups, without statistically significant difference observed. Factors such as temperature, mood fluctuations, spicy food and excessive facial cleaning were identified as primary aggravating factors, while ventilation, cool air, cold compression and spray usage were the main mitigating factors (Table 2). Statistical analysis revealed no significant differences between the NR and ETR groups regarding these factors ($p > .05$).

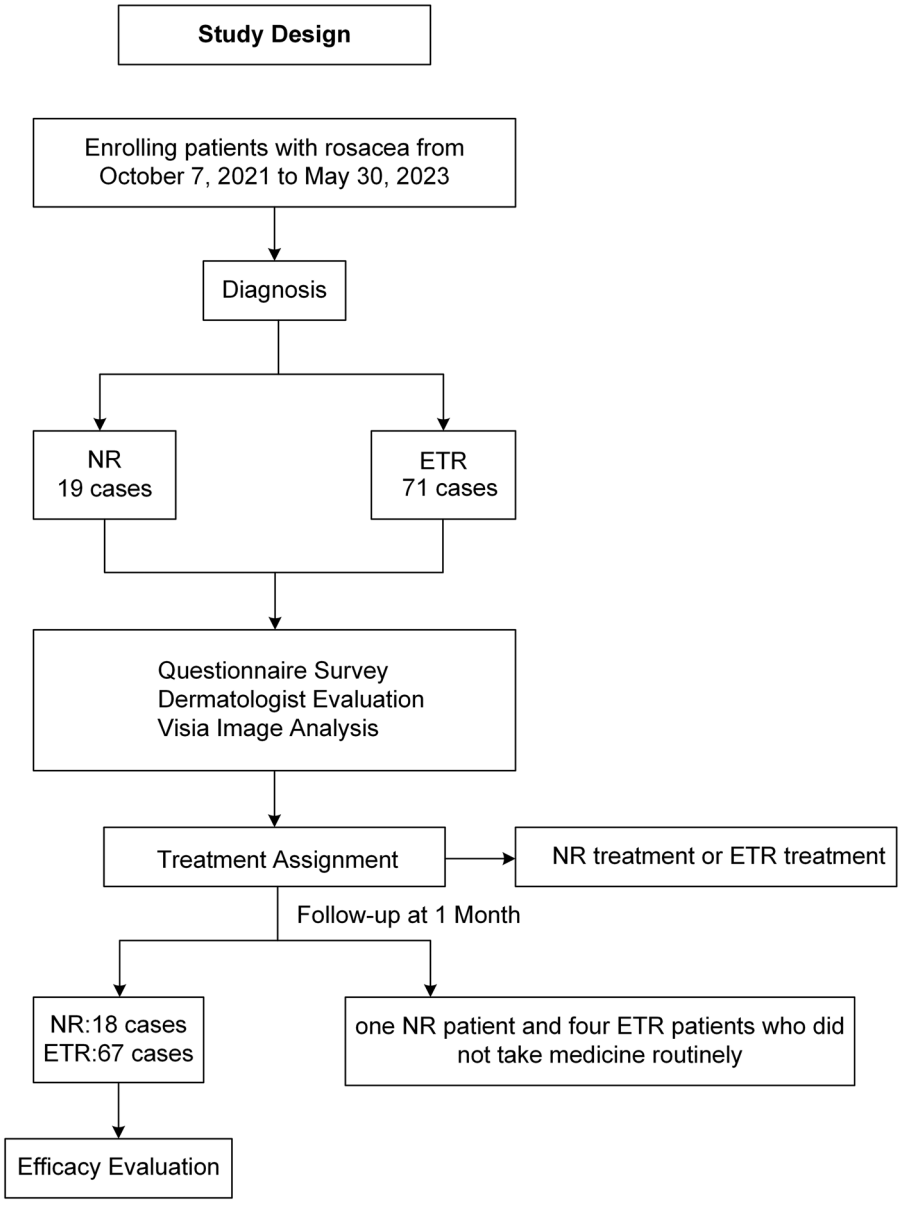

Figure 2. Flowchart of participants.

Skin type and facial erythema evaluation

Mixed dry skin was present in 13 of NR patients and 42 (57.5%) of ETR patients (Figure 3(B)). However, facial flushing affected sleep in 11 NR patients compared to 18 (24.7%) of ETR patients (Figure 3(C)). The median GFSBS for the NR group was 3 (Q1–Q3: 2–5) points, while the ETR group had a median sleep score of 1 (Q1–Q3: 0–4) point (Figure 3(D)). Overall flushing symptom scores were higher in the NR group, at 4 (Q1–Q3: 1–7) points compared with 3 (Q1–Q3: 1–4) points in the ETR group (Figure 3(E)), indicating more severe flushing and disrupted sleep due to flushing. Significantly different outcomes were observed in facial flushing-affected sleep scores and overall flushing symptom scores between the two groups ($Z = 2.67$, $p < .008$; $Z = 2.06$, $p < .05$).

VISIA® skin image analysis of NR and ETR

VISIA® skin image analysis showed that facial erythema in NR patients tended to affect the lateral cheek more frequently than in ETR patients (Figure 1). Midfacial erythema, classified according to VISIA® images, was observed in 15 NR patients and 53 (72.6%) ETR patients, without statistically significant differences between the groups ($p > .05$).

Efficacy of drug treatment

We found one NR patient and four ETR patients who did not take medicine routinely as prescribed by the doctors at the one-month follow-up, consequently their data were excluded from the analysis of the efficacy of drug treatment for more clarity and readability. In seven

Table 1. Demographic and clinical characteristics of NR and ETR patients.

Category	NR (19 cases)	ETR (73 cases)	*p* Value
Sex, *n* (%)			
Male	0	2 (2.7)	
Female	19	71 (97.3)	
Age (years)[a]	26 (23–33)	28 (24–31.5)	
Disease duration (months)[a]	24 (12–48)	24 (12–38)	
Facial symptoms (%)			
Burning	19	63 (86.3)	.12
Swelling	12	32 (43.8)	.20
Stinging	7	23 (31.5)	.78
Pruritus*	7	47 (64.4)	.04
Dryness*	6	51 (69.9)	.003
Ocular symptoms	7	22 (30.1)	.59
Facial signs			
Erythema	19	73 (100)	–
Telangiectasia	10	25 (34.2)	.19
Papule and pustules	6	31 (42.5)	.44
Phymatous changes	5	10 (13.7)	.29
Erythema pattern in VISIA			
Midfacial erythema	15	53 (72.6)	.77

NR: neurogenic rosacea; ETR: erythematotelangiectatic rosacea.
The four-cell table of categorical variables in this study has a theoretical number, $T < 1$; therefore, Fisher's exact test was used. All facial symptoms were patient-reported, while all facial signs were physician-diagnosed, among which midfacial erythema was physician-diagnosed according to the images taken by VISIA®.
[a]Data provided as the median (interquartile range).
*$p < .05$, indicating a statistically significant difference.

of the 18 patients with NR, anticonvulsant drugs such as gabapentin and pregabalin or antidepressants such as mirtazapine, sertraline, topiramate showed effectiveness, while in the rest, slight improvement was achieved or medications deemed ineffective. In the ETR group, in 59 (85.5%) of the patients, conventional treatment was effective, showing a statistically significant difference between the groups (Figure 3(F), $p < .05$).

Discussion

Rosacea is a chronic inflammatory skin condition that disproportionately affects women more than men, with the most prevalent clinical subtype being ETR [12]. ETR is characterized by symptoms of burning or tingling in approximately 79.8% of patients with ETR [13]. Scharschmidt et al. [2] identified NR as a distinct subtype of rosacea. However, the existing literature on NR primarily consists of case reports and case series. Scharschmidt et al. [2] and Kim et al. [6] reported that papules and pustules were rare in patients with NR and that they had symptoms similar to those of ETR, such as paroxysmal flushing, persistent erythema and telangiectasia. In this study, a comparative analysis was conducted to compare the clinical manifestations and therapeutic responses to medication in patients with NR and ETR and investigate whether NR is a distinct subtype of rosacea in the Chinese population.

Statistical analysis revealed no significant differences between the NR and ETR groups regarding clinical features, except for dryness and itching. However, there were higher incidences of facial burning, swelling, stinging and ocular symptoms in the NR group compared to the ETR group. The only clinically significant differences between the NR and ETR groups were observed in pruritus and dryness, both more prevalent in ETR patients. Both pruriception and nociception constitute nocifensive sensory modalities mediated by thinly myelinated Aδ and unmyelinated C-fibres. However, nociception engages a broader spectrum of neural substrates, including additional Aδ-fibre subtypes and sympathetic efferent involvement. Itch-responding neurons are also sensitive to pain stimuli [14]. This hierarchical sensory integration explains the clinical phenomenon of pain-induced itch suppression observed in neuropathic conditions.

Kim et al.'s case-control study [6] demonstrated cheek-predominant erythema distribution with rare nasal involvement, and absence of papules/hypertrophic changes in NR cases. Our facial assessment via EMR-VISIA integration revealed no intergroup differences in erythema severity, telangiectasia density, papulopustular lesions, hypertrophic manifestations or midfacial erythema localization.

Li et al. [13] reported that 37.8% of rosacea patients have a familial predisposition. Exacerbating factors such as temperature fluctuations, emotional stress, excessive facial cleansing and a diet high in spicy foods were consistent with previous findings [6,15,16]. Cooling interventions provided relief for facial symptoms in both groups, though no statistically significant difference was found.

Recent research has reported diverse comorbidities of rosacea, such as migraines, anxiety, depression, Alzheimer's disease and Parkinson's disease [17–19]. A retrospective study of 840 rosacea cases in Chinese women revealed that anxiety and depression were prevalent in 48.8% and 35.2% of cases, respectively [15]. Scharschmidt et al. [2] reported that 43% of patients with NR exhibited neurological symptoms, and 50% had neuropsychiatric disorders, but no control group was included in their study. In our study, the differences in symptoms were not statistically significant ($p > .05$). Scharschmidt et al. [2] reported high incidences of facial flushing and neurosensitive symptoms in NR patients, significantly impacting their quality of life. Our study found that NR patients had more severe flushing and more disrupted sleep due to flushing compared to ETR patients. In the initial phases of treatment for these patients, conventional therapies may be employed. Should resistance to treatment

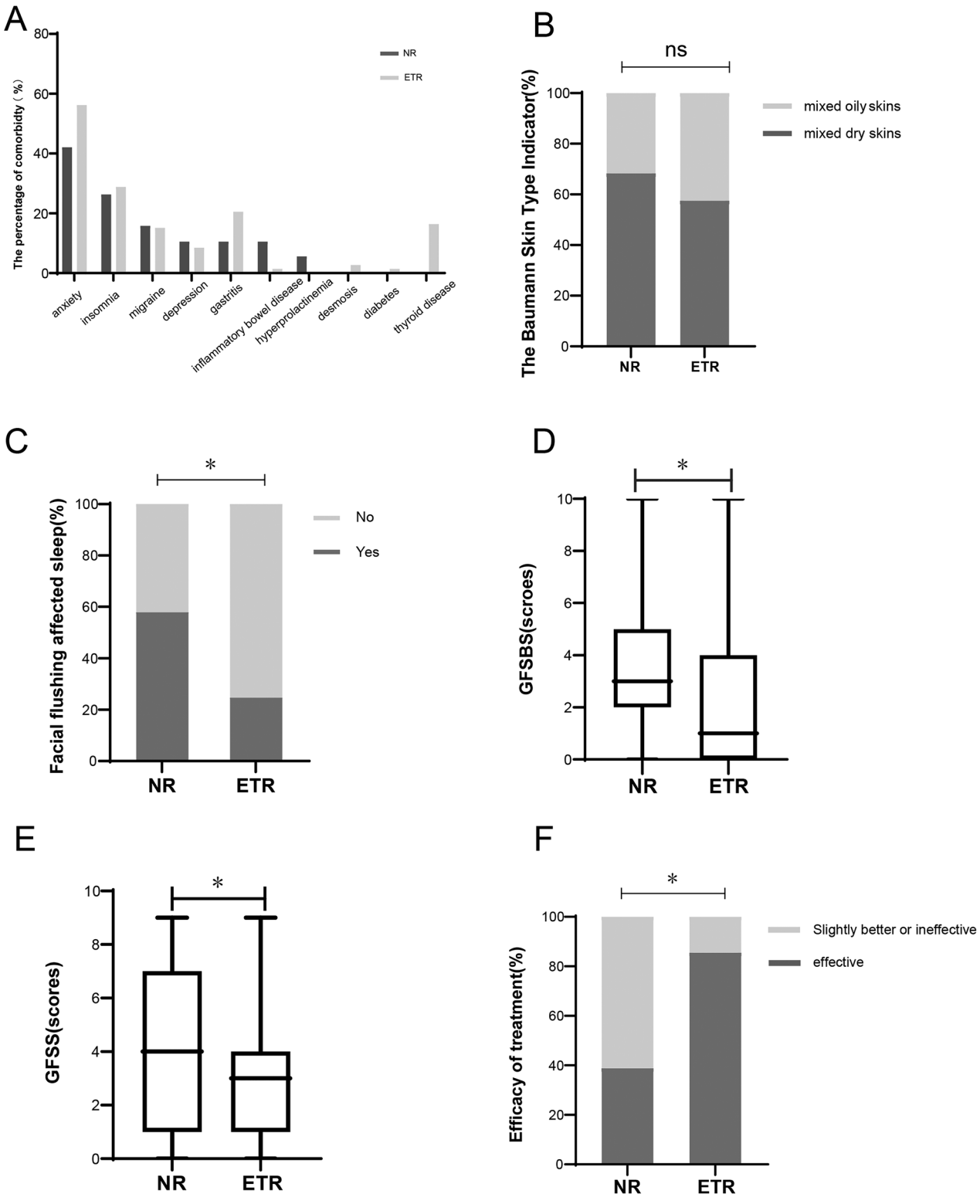

Figure 3. (A) The percentage of comorbidities ($p > .05$). (B) Baumann oil/dry skin subtype isolation. (C) Facial flushing affected sleep. (D) The Global Flushing Sleep Bothersome Score (GFSBS). (E) Global Flushing Symptom Score (GFSS). (F) Efficacy of treatment. NR: neurogenic rosacea; ETR: erythematotelangiectatic rosacea. *$p < .05$, statistically significant; ns: $p > .05$, the difference was not statistically significant.

emerge, the administration of anticonvulsants and antiepileptics should be contemplated.

The pathogenesis of rosacea involves multifaceted mechanisms, with localized neurovascular dysregulation playing a pivotal role. Neurogenic inflammation has been established as a critical mediator in this neurovascular dysfunction, characterized by the coordinated release of neuropeptides including calcitonin gene-related

Table 2. Analysis of factors influencing clinical features of neurogenic rosacea (NR) and erythema telangiectasia rosacea (ETR) (case (%)).

Category	NR (19 cases)	ETR (73 cases)	*p* Value
Improper skin care habits	13	47 (64.4)	.79
Family history	4	18 (24.7)	1.00
Aggravating or precipitating factors			
Temperature	18	69 (94.5)	1.00
Mood fluctuations	18	67 (91.8)	1.00
Excessive facial cleaning	12	43 (58.9)	.79
Spicy food	10	48 (65.8)	.30
Cosmetic treatment or replacement of skin care products	7	39 (53.4)	.30
Changes of skin care products			
Alcohol exacerbation	6	34 (46.6)	.30
Menstrual period	6	29 (39.7)	.60
May contain corticosteroid products	5	22 (30.1)	1.00
Facial usage of retinoic and glycolic acid and salicylic acid products	4	19 (26.0)	.77
Anti-demodex products	3	17 (23.3)	.77
Mitigating factors			
Ventilation environment	18	64 (87.7)	.68
Cold air	16	62 (84.9)	1.00
Ice pack	12	57 (78.1)	.23
Spray	11	52 (71.2)	.28

The four-cell table of categorical variables in this study has a theoretical number, $T < 1$.

peptide (CGRP) and concomitant pro-inflammatory cytokines [20]. This neuroimmune cascade predisposes cutaneous tissues to pathological vasodilation and neurosensory disturbances manifesting as erythema, burning sensations and thermal allodynia. Clinically, NR patients exhibit exacerbated facial flushing, sting and burning sensation. Emerging evidence from clinical trials has demonstrated therapeutic efficacy of neuromodulators – particularly paroxetine [21], gabapentin [22] and CGRP monoclonal antibodies [23] – in ameliorating neurogenic flushing episodes and cutaneous dysesthesia. The pharmacodynamic evidence substantiates the critical pathogenic role of neurogenic inflammation in rosacea subtypes manifesting with erythema and prominent neurosensory symptoms, which may correspond to either ETR or NR. Our findings suggest that NR may represent severe cases of ETR rather than a distinct subtype, a novel observation reported for the first time in the literature.

The current diagnostic criteria for NR have incorporated the standards utilized in all prior NR clinical studies. However, these criteria are insufficient to fully differentiate NR from non-NR based on clinical symptoms alone. Potential reasons include: (1) NR may not represent a distinct subtype; (2) the existing diagnostic criteria for NR may lack sufficient accuracy and specificity. Therefore, more precise methods are required to distinguish this unique type from common subtypes. Li and coworker [9] reported that the use of molecular diagnostic models can improve the specificity of NR diagnosis. More studies are needed to confirm the clinical promotion of this method. Or there may be other diagnostic criteria that are more in line with clinical practice.

Our study had limitation that must be acknowledged. Due to the limited sample size of NR patients, an exploratory analysis was conducted in lieu of a formal statistical analysis. Consequently, the study lacked sufficient power to detect significant differences. Future studies incorporating a larger cohort of NR patients are necessary to provide statistical weight to these findings.

Conclusions

From this study, there were few differences between ETR and NR in the Chinese population. NR could be referred to as ETR in patients with refractory erythema. However, further large-scale studies are needed to delineate the characteristics of rosacea in patients exhibiting neural hyper-responsiveness and refractory erythema and confirm whether NR should be classified as a distinct subtype.

Acknowledgements

All patients and investigators were involved in this clinical study. All authors have read and approved the final work. Tingwei Liu: writing – original draft, investigation and data curation; Zhi Yin: writing – original draft, investigation and data curation; Meng Tao: writing – original draft, data curation and investigation; Xiaoqi Meng: data curation and investigation; Hui Zhong: supervision; Yang Xu: supervision, writing – review and editing, methodology; Xiulan Sun: supervision and methodology. All authors have read and approved the final version of the manuscript.

Author contributions

CRediT: **Tingwei Liu**: Data curation, Investigation, Writing – original draft; **Zhi Yin**: Data curation, Investigation, Writing – original draft; **Meng Tao**: Data curation, Investigation, Writing – original draft; **Xiaoqi Meng**: Data curation, Investigation; **Hui Zhong**: Supervision; **Yang Xu**: Methodology, Supervision, Writing – review & editing; **Xiulan Sun**: Methodology, Supervision.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

No funding was received for this research.

ORCID

Tingwei Liu http://orcid.org/0009-0009-8500-2227

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

[1] Wilkin J, Dahl M, Detmar M, et al. Standard classification of rosacea: report of the National Rosacea Society Expert Committee on the Classification and Staging of Rosacea. J Am Acad Dermatol. 2002;46(4):584–587. doi: 10.1067/mjd.2002.120625.

[2] Scharschmidt TC, Yost JM, Truong SV, et al. Neurogenic rosacea: a distinct clinical subtype requiring a modified approach to treatment. Arch Dermatol. 2011;147(1):123–126. doi: 10.1001/archdermatol.2010.413.

[3] Schram AM, James WD. Neurogenic rosacea treated with endoscopic thoracic sympathectomy. Arch Dermatol. 2012;148(2):270–271. doi: 10.1001/archdermatol.2011.2615.

[4] Parkins GJ, Maan A, Dawn G. Neurogenic rosacea: an uncommon and poorly recognized entity? Clin Exp Dermatol. 2015;40(8):930–931. doi: 10.1111/ced.12630.

[5] Hurtado DIC, Pérez APC, López RFR. Neurogenic rosacea successfully treated with neuromodulators and intense pulsed light. An Bras Dermatol. 2024;99(2):296–297. doi: 10.1016/j.abd.2022.09.016.

[6] Kim HO, Kang SY, Kim KE, et al. Neurogenic rosacea in Korea. J Dermatol. 2021;48(1):49–55. doi: 10.1111/1346-8138.15629.

[7] Schwab VD, Sulk M, Seeliger S, et al. Neurovascular and neuroimmune aspects in the pathophysiology of rosacea. J Investig Dermatol Symp Proc. 2011;15(1):53–62. doi: 10.1038/jidsymp.2011.6.

[8] Gallo RL, Granstein RD, Kang S, et al. Standard classification and pathophysiology of rosacea: the 2017 update by the National Rosacea Society Expert Committee. J Am Acad Dermatol. 2018;78(1):148–155. doi: 10.1016/j.jaad.2017.08.037.

[9] Mao R, Li J. Construction of a molecular diagnostic system for neurogenic rosacea by combining transcriptome sequencing and machine learning. BMC Med Genomics. 2024;17(1):232. doi: 10.1186/s12920-024-02008-0.

[10] Norquist JM, Watson DJ, Yu Q, et al. Validation of a questionnaire to assess niacin-induced cutaneous flushing. Curr Med Res Opin. 2007;23(7):1549–1560. doi: 10.1185/030079907x199637.

[11] Baumann L. Understanding and treating various skin types: the Baumann Skin Type Indicator. Dermatol Clin. 2008;26(3):359–373, vi. doi: 10.1016/j.det.2008.03.007.

[12] Barakji YA, Rønnstad ATM, Christensen MO, et al. Assessment of frequency of rosacea subtypes in patients with rosacea: a systematic review and meta-analysis. JAMA Dermatol. 2022;158(6):617–625. doi: 10.1001/jamadermatol.2022.0526.

[13] Li J, Wang B, Deng Y, et al. Epidemiological features of rosacea in Changsha, China: a population-based, cross-sectional study. J Dermatol. 2020;47(5):497–502. doi: 10.1111/1346-8138.15301.

[14] Anzelc M, Burkhart CG. Pain and pruritus: a study of their similarities and differences. Int J Dermatol. 2020;59(2):159–164. doi: 10.1111/ijd.14678.

[15] Yang F, Wang L, Shucheng H, et al. Differences in clinical characteristics of rosacea across age groups: a retrospective study of 840 female patients. J Cosmet Dermatol. 2023;22(3):949–957. doi: 10.1111/jocd.15470.

[16] Lee JB, Moon J, Moon KR, et al. Epidemiological and clinical features of rosacea in Korea: a multicenter cross-sectional study. J Dermatol. 2018;45(5):546–553. doi: 10.1111/1346-8138.14281.

[17] Holmes AD, Spoendlin J, Chien AL, et al. Evidence-based update on rosacea comorbidities and their common physiologic pathways. J Am Acad Dermatol. 2018;78(1):156–166. doi: 10.1016/j.jaad.2017.07.055.

[18] Egeberg A, Hansen PR, Gislason GH, et al. Clustering of autoimmune diseases in patients with rosacea. J Am Acad Dermatol. 2016;74(4):667–672.e1. doi: 10.1016/j.jaad.2015.11.004.

[19] Wollina U. Is rosacea a systemic disease? Clin Dermatol. 2019;37(6):629–635. doi: 10.1016/j.clindermatol.2019.07.032.

[20] Chen C, Wang P, Zhang L, et al. Exploring the pathogenesis and mechanism-targeted treatments of rosacea: previous understanding and updates. Biomedicines. 2023;11(8):2153. doi: 10.3390/biomedicines11082153.

[21] Wang B, Huang Y, Tang Y, et al. Paroxetine is an effective treatment for refractory erythema of rosacea: primary results from the prospective rosacea refractory erythema randomized clinical trial. J Am Acad Dermatol. 2023;88(6):1300–1307. doi: 10.1016/j.jaad.2023.01.044.

[22] Ma G, Zhang Y, Gao Q, et al. Gabapentin improves the flushing of rosacea, but not other rosacea symptoms or quality of life: results from a multicenter, randomized, double-blind, placebo-controlled pilot study. J Am Acad Dermatol. 2025;92(4):920–922. doi: 10.1016/j.jaad.2024.12.003.

[23] Wienholtz NKF, Christensen CE, Do TP, et al. Erenumab for treatment of persistent erythema and flushing in rosacea: a nonrandomized controlled trial. JAMA Dermatol. 2024;160(6):612–619. doi: 10.1001/jamadermatol.2024.0408.