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Research Article

Sensory Stimulation versus Foot Reflexology for Consciousness Recovery and Physiological Stability in ICU Patients with Disorders of Consciousness: A Randomized Controlled Trial

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Abstract

Background/Aim: To compare the effects of Dyang sensory stimulation (DSS) and foot reflexology (FR) on the level of consciousness and physiological parameters in intensive care unit (ICU) patients with disorders of consciousness (DOC).

Methods: This randomized controlled trial used a three-arm parallel design and included 60 adults in the ICU with disorders of consciousness (Glasgow Coma Scale [GCS] score ranging from 3 to 7) admitted to a university hospital in Iran (2024–2025). Patients were randomly allocated in a 1:1:1 ratio to receive Dyang sensory stimulation (DSS), foot reflexology (FR), or routine care using block randomization and allocation concealment. The interventions were provided for 10 minutes twice per day for 7 consecutive days. The primary outcome of the study was the improvement in the total GCS score from baseline to 7 days. GCS sub-scale scores and physiological parameters were recorded as secondary outcomes. A paired t-test, analysis of variance (ANOVA), and analysis of covariance (ANCOVA) were applied for data analysis using SPSS version 24, with a significance level set at α=0.05.

Results: It was observed that there was a great improvement in total GCS in all three groups: DSS (from 5.35±1.32 to 7.17±2.76; p=0.018), FR (from 4.57±1.30 to 6.84±2.71; p=0.002) and control group (from 5.45±1.46 to 6.65±2.51; p=0.008). Whereas some level of improvement in GCS was shown in all three groups, there was no significant difference between groups in mean GCS change (ANOVA p=0.420; ANCOVA p=0.602). The results indicate that there was a significant decrease in systolic BP in the FR group, but the difference between groups in systolic BP was not statistically significant. There were no adverse effects noted.

Conclusion: DSS and FR procedures were shown to be effective in the treatment of patients and led to visible improvements in GCS in patients in three groups during the study; however, neither group showed any type of advantage during the research. The results of the research create the basis for conducting further studies of the phenomenon.

Keywords: Disorders of Consciousness; Sensory Stimulation; Dyang Protocol; Foot Reflexology; Intensive Care Unit

Introduction

Disorders of consciousness (DOC), which comprise coma as well as the vegetative state and minimally conscious state, are prevalent and grave effects of severe acute brain injuries resulting from neurological, traumatic, and vascular causes[1,2]. Around 20 million cases of impaired consciousness are recorded in hospitals in different countries per year[3], with the annual rates of coma incidence reaching 135 and 258 per 100,000 people, respectively, in the UK and USA[4]. The management of DOC patients in ICUs is difficult: pharmacological agents that are used to restore consciousness show varying effectiveness, and complex neurostimulation methods need specialized equipment,

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which is absent in most under-resourced parts of the world[5,6].

Sensory stimulation is an easily applied, non-medical adjunct to basic ICU treatment for DOC patients. The concept is based on the principles of Hebbian neuroplasticity: continuous multimodal sensory input is believed to activate the ascending reticular activating system, enhance synaptic connectivity in the corticothalamic system, and facilitate neurorecovery[7,8]. Various modalities have been studied, including auditory stimulation, tactile stimulation, olfactory stimulation, visual stimulation, and motion stimulation[9].

The Dyang sensory stimulation (DSS) strategy involves a combination of five different sensory modalities, including olfaction, vision, audition, touch, and kinesthesia, in a simple bedside session that was first evaluated by Mohammadi et al. (2022), leading to a significant rise in GCS level when the duration of DSS is extended (up to 60 minutes, 2 times a day). Foot reflexology (FR) refers to a method aimed at exerting pressure on reflex points on the foot, and it is proposed that this technique may affect the activity of the autonomic nervous system and enhance blood flow to certain regions of the brain using neurohormonal mechanisms. In another randomized controlled trial, reflexology was tested in relation to anxiety in patients undergoing coronary angiography; however, the participant pool and outcome are different than those described in this paper.[13] Bahonar et al. (2019) demonstrated that FR combined with nature sounds significantly improved GCS scores and hemodynamic parameters in comatose patients[14].

Despite growing interest, comparative evidence directly comparing different structured sensory stimulation protocols remains absent. Prior trials have been limited by single-arm designs, absence of active comparators, inadequate allocation concealment, and open-label outcome assessment, precluding definitive efficacy conclusions[2,15]. The present trial was therefore designed to address this gap by directly comparing DSS versus FR versus standard ICU care in a rigorously blinded randomized design. The first goal was to determine whether GCS total score improvement differed significantly between DSS or FR and standard care within seven days. Secondary aims included assessing changes in GCS subscale scores, physiological parameters, and intervention safety.

Materials and Methods

Study Design and Setting

We conducted a three-arm, parallel-group randomized controlled trial in the Intensive Care Unit (ICU) of a university hospital (four ICU wards) in Iran between January 2024 and April 2025. The institute's Ethics Committee approved the trial (IR.KAUMS.MEDNT.REC.1402.104), and it was prospectively registered in the Iranian Registry of Clinical Trials (IRCT20230903059339N1). The processes were all performed in accordance with the Declaration of Helsinki and the CONSORT 2010 Statement[16,17].

Participants

Inclusion requirements: an individual aged between 18 and 65; admission to an intensive care unit for over 72 hours; presence of a neurologic cause of loss of consciousness confirmed by a physician; total Glasgow Coma Scale (GCS) score ranging from 3 to 7; mechanical ventilation; no leg fractures or skin conditions that would prevent safe delivery of treatment; and no serious pre-existing hearing or vision problems. Exclusion requirements: guardian revoked the consent; death or transfer during the week of study; planned surgical procedure; seriousness of the health condition that would interrupt protocol. The data collected during the session were not used for the analysis if the participant had been given any sedative or painkiller in the two hours before the session.

Sample Size

Sample size was calculated as per parameters in Charan and Biswas[19] and with information from the prior ICU massage trial by Vahedian-Azimi et al.[20] regarding the estimated clinical effect. Estimates assumed a between-group GCS difference of at least 2 points, an approximate pooled standard deviation of 2.4, a 2-sided α of 5%, and 90% power, which gave a minimum of 17 participants per group. With 15% attrition, the target was raised to 20 participants per group (N = 60).

Randomization and Allocation Concealment

The allocation sequence was developed by an independent biostatistician utilizing specific software based on balanced block randomization (block sizes of 4 and 6). The allocation sequence was organized to ensure the therapeutic groups were randomized by DOC etiology and in a 1:1:1 ratio. The allocation sequence was kept in envelopes numbered sequentially, made from opaque, lockable, bend-proof material. The closing of the envelope occurred when the enrollment nurse

opened it immediately before the start of the intervention.

Masking

Masking was maintained for outcome assessors and data analysts. Outcome assessors were independent ICU nurses who were not involved in intervention delivery and had no access to allocation records or intervention logs. The biostatistician analyzed a coded dataset, with group labels disclosed only after completion of the planned analyses.

Interventions

All procedures were executed on a 9 am to 12 pm and 3 pm to 6 pm timetable over a seven-day hospital stay, with a registered nurse with no less than two years of experience in an intensive care unit performing the procedures while ensuring privacy. In cases where GCS achieved 15 before the seventh day, procedures were discontinued. Should a subject be transferred during hospitalization, the procedure continues at the new location and respective medical staff office?

For the DSS (Arm A) there were five defined stimuli occurring within each 10 minute period: (1) odour: a cotton ball soaked with a rose fragrance was held up to the nose for five seconds twice; (2) vision: an appropriately calibrated lamp was held at the distance of 30 cm from each eye for two seconds for each eye in three cycles; (3) hearing: calling the name of a patient at a volume measured at 60-70 dB at a distance of 10 cm from each ear along with orientation information (the date and the place), repeated three times; (4) touch: the pressure applied tactically on the inside of palms and the feet; (5) passive motion: a motion of various joints was conducted and repeated five times (as is illustrated in the picture below).

The participants in Arm B of the study underwent 10 minutes of combined general foot preparation and targeted reflex zone stimulation. General foot preparation lasted for 5 min and included passive flexion-extension, medial and lateral rotation, calcaneal mobilization, digital traction, zigzag thumb-walking, and effleurage. The stimulation of the reflex zones took 5 min and consisted of direct thumb pressure, using the Ingham method, sustained with a force of about 3-5 N on the solar plexus zone (the central plantar surface), cardiac zone (the medial plantar surface of the left foot), and cranial/cerebral zones (the plantar surfaces of all toes on both feet). Arm C served as a control arm and entailed standard ICU nursing care, involving routine passive positioning and basic range-of-motion exercises according to institutional protocols, GCS monitoring, repositioning at 2-hour intervals, pupillary reflex checks, careful vital signs monitoring, oral hygiene, and other typical measures. These components were also given to the intervention groups, accompanied by corresponding interventions.

Outcomes

The main result measured was the alteration in overall GCS score (ranging from 3 to 15) from the start to the 7th day, evaluated by a blind judge according to the standard GCS scale. Other outcomes included changes in elements of GCS (responses from eyes, speech, and motor system) as well as other indicators, including heart rate, blood pressure, body temperature, and oxygen saturation. All the physiological measurements were achieved using the same biomedical facility conditions.

Statistical Analysis

The Kolmogorov-Smirnov test was utilized to assess data normality. Descriptive statistics (mean ± SD; frequency, %) were computed for all variables. For between-group comparisons at baseline, one-way ANOVA was used for continuous variables, while chi-square or Fisher's exact test was employed among categorical variables. Pre-post changes within groups were analyzed using paired t-tests (two-tailed). For between-group comparisons of mean changes, one-way ANOVA was performed after Bonferroni post hoc testing. Analysis of covariance (ANCOVA) adjusting for baseline GCS, age, and diagnosis was prespecified as the primary test under between-group inferential comparisons. The effect size was computed as Cohen's d (95% confidence interval). The analyses were performed based on the intention-to-treat principle, and any missing session data (3 sessions) were replaced with data from the last observation carried forward (LOCF). Sensitivity analysis was conducted using a per-protocol approach, excluding participants with more than 2 missed sessions. The threshold for statistical significance was set at $\alpha = 0.05$ (two-tailed). All analyses were performed using SPSS version 24.0 (IBM Corp., Armonk, NY, USA).

Results

Participant Flow and Baseline Characteristics

Out of the 89 screened patients, 29 were excluded (11 had GCS scores that were ineligible, 8 had contraindications for intervention, 4 had severe sensory impairments, 3 had surgeries scheduled) and 3 had

guardians who refused consent. The final randomization consisted of 60 participants: 17 in DSS, 19 in FR, and 20 in the control group who received appropriate intervention (Figure 2). In terms of baseline characteristics, the different groups were similar (Table 1). Mean age was similar across groups (44.0 to 50.9 years). All patients had intracerebral hemorrhages. There were no statistically significant differences between groups (all p>0.05).

Primary Outcome: GCS Total Score

Total GCS score improved significantly in each of the three groups (Table 2): DSS (+1.82±2.85; p=0.018), FR (+2.26±2.80; p=0.002), and control (+1.20± 1.82; p=0.008). Between-group assessment of average changes showed no statistically relevant differences, either in raw (ANOVA: p=0.420) or standard (ANCOVA: p=0.602) calculations (Table 3). Cohen's d values for DSS as compared to control are 0.22 (95% CI −0.41 to 0.84), and for FR as compared to control are 0.39 (95% CI −0.24 to 1.01).

Secondary Outcomes: GCS Subscales

DSS group showed significant improvement in eye-opening (p=0.001) and total GCS scores (p=0.018), but not in verbal or motor scores (p=0.104 and p=0.368, respectively). In the FR group, there were significant improvements in eye-opening (p=0.026), motor (p<0.001), and total GCS (p=0.002) scores, but not in verbal scores (p=0.135). The control group demonstrated significant improvements in eye-opening (p=0.001) and total GCS scores (p=0.008). Between-group comparisons of the scores related to the changes in subscales were insignificant: eye-opening changes (ANOVA p=0.263; ANCOVA p=0.336), verbal changes (p=0.813; p=0.813), and motor changes (p=0.261; p=0.661).

Secondary Outcomes: Physiological Parameters

In the FR group, SBP dropped significantly (from 138.47±18.91 to 124.15±18.43 mmHg; mean change −14.32±19.60 mmHg; p=0.005), the only significant within-group physiological change. There were no statistically significant changes in any of the other parameters such as HR, DBP, body temperature, and SpO_2 for any group (all p>0.05). The tests done for the comparison between groups for these physiological parameter changes also yielded non-significant results (Table 3; all ANOVA and ANCOVA p>0.05).

Safety

Any possible rare adverse effects were predefined in the study protocol, and the observation of any such events would be reported to the ethics committee. No adverse events as per the protocol were recorded in the study, nor were there any adverse effects related to the intervention that affected the study subjects.

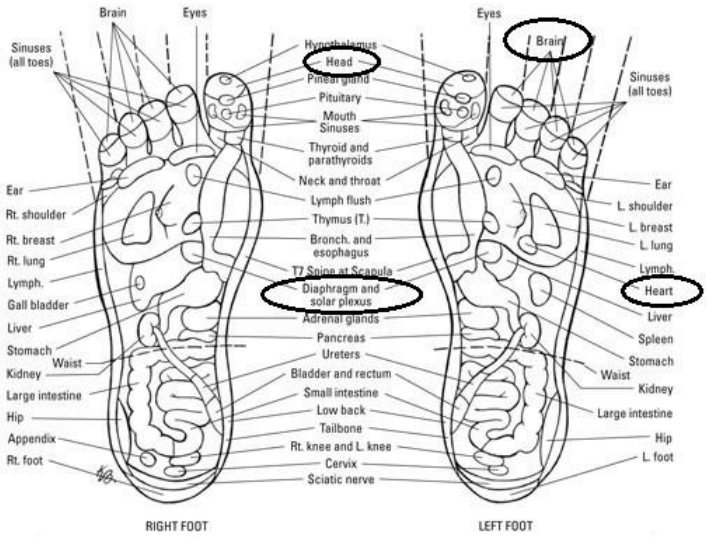


Figure 1. Foot reflexology chart with the head/brain, diaphragm and solar plexus, and heart reflex zones circled

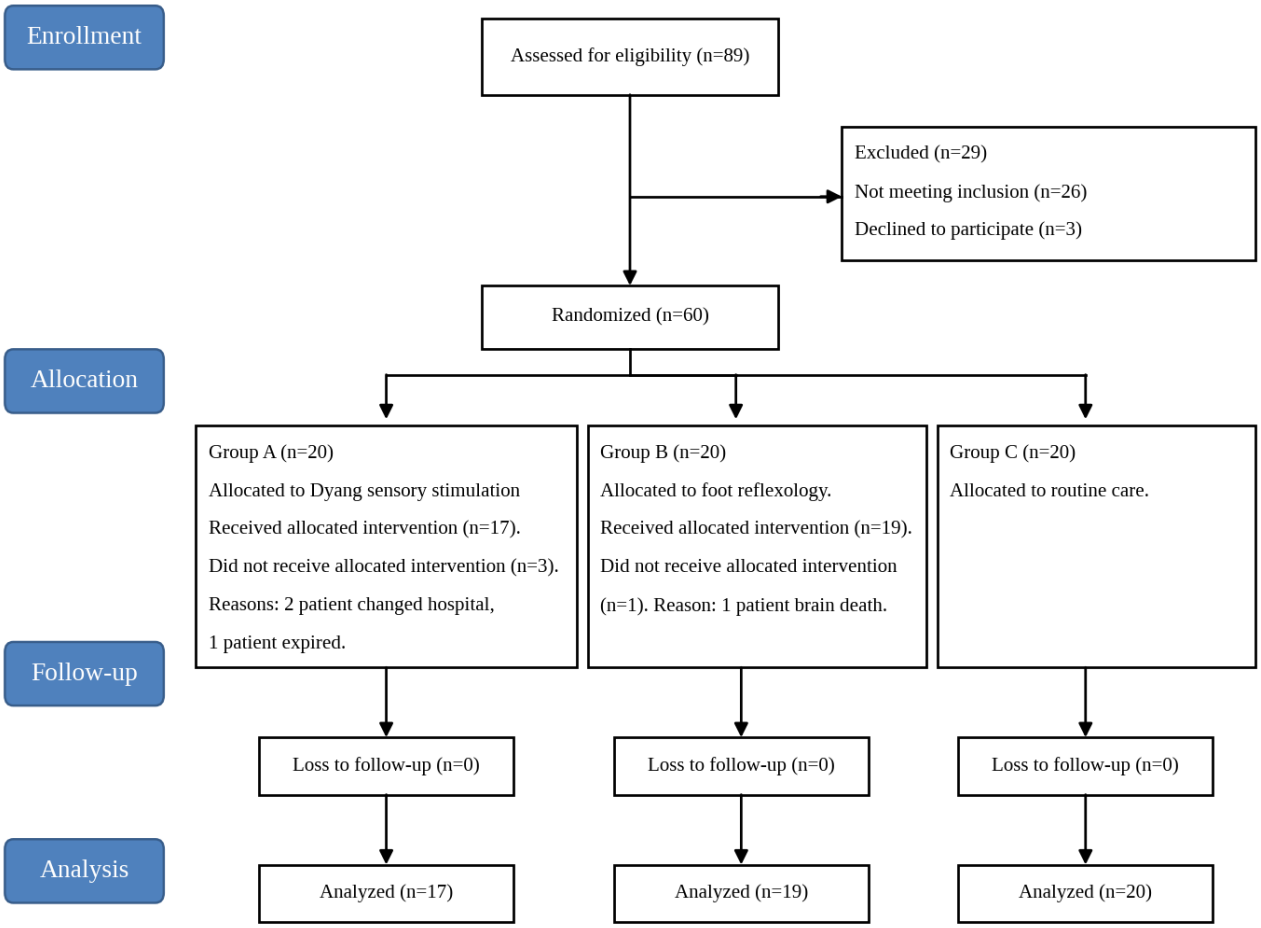


Figure 2. CONSORT flowchart

Table 1. Baseline demographic and clinical characteristics of patients with disorders of consciousness by study group

Characteristic	DSS (n=17)	FR (n=19)	Control (n=20)	P value
Age, years, mean ± SD	50.88 ± 13.90	45.94 ± 14.97	44.00 ± 16.06	0.37
Length of hospital stay, days, mean ± SD	7.47 ± 5.01	8.10 ± 5.07	10.80 ± 8.64	0.26
Underlying disease, n (%)	14 (82.4)	12 (63.2)	12 (60.0)	0.10
Male	14 (82.4)	14 (73.7)	14 (70.0)	0.25
Female	3 (17.6)	5 (26.3)	6 (30.0)	
Single	2 (11.8)	6 (31.6)	5 (25.0)	0.24
Married	15 (88.2)	13 (68.4)	15 (75.0)	
Illiterate	2 (11.8)	5 (26.3)	6 (30.0)	0.34
Below diploma	9 (52.9)	8 (42.1)	6 (30.0)	
Diploma and higher	6 (35.3)	6 (31.6)	8 (40.0)	
Employed	5 (29.4)	6 (31.6)	7 (35.0)	0.29
Homemaker	3 (17.6)	4 (21.1)	5 (25.0)	
Other	9 (52.9)	9 (47.4)	8 (40.0)	
B.T	3 (17.6)	3 (15.8)	1 (5.0)	0.25
CVA	4 (23.5)	1 (5.3)	6 (30.0)	
ICH	10 (58.8)	15 (78.9)	13 (65.0)	

DSS = Dyang sensory stimulation; FR = foot reflexology; B.T = abbreviation as recorded in the original table (author verification required); CVA = cerebrovascular accident; ICH = intracerebral hemorrhage.

DSS = Dyang sensory stimulation; FR = foot reflexology; TBI = traumatic brain injury; CVA = cerebrovascular accident; ICH = intracerebral hemorrhage.

Table 2. Glasgow Coma Scale scores and physiological parameters before and after intervention in each study group (within-group comparison)

Variable	Time	DSS (n=17)		FR (n=19)		Control (n=20)	
		Mean ±SD	p	Mean ±SD	p	Mean ±SD	p
Eye-opening	Before	1.52±0.71	0.001*	1.52±0.77	0.026*	1.75±1.06	0.001*
	After	2.64±1.27		2.26±0.93		2.25±1.16	
Verbal response	Before	1.00±0.00	0.104	1.00±0.00	0.135	1.00±0.00	0.083
	After	1.23±0.56		1.26±0.73		1.15±0.36	
Motor response	Before	2.82±1.38	0.368	2.05±1.07	<0.001*	2.70±1.30	0.061
	After	3.29±1.64		3.31±1.60		3.25±1.58	
Total GCS	Before	5.35±1.32	0.018*	4.57±1.30	0.002*	5.45±1.46	0.008*
	After	7.17±2.76		6.84±2.71		6.65±2.51	
Heart rate (bpm)	Before	82.94±17.35	0.943	91.31±20.66	0.153	87.60±17.78	0.110
	After	82.58±18.83		83.31±14.82		80.35±18.51	
SBP (mmHg)	Before	134.35±20.95	0.662	138.47±18.91	0.005*	127.35±20.33	0.630
	After	131.41±17.72		124.15±18.43		123.90±32.95	
DBP (mmHg)	Before	81.58±14.64	0.751	84.26±13.59	0.652	78.90±14.94	0.558
	After	80.11±12.98		82.57±15.62		81.35±16.85	
Body temp (°C)	Before	36.69±0.82	0.895	36.84±0.69	0.416	36.65±0.93	0.380
	After	36.71±0.42		36.67±0.41		35.22±0.81	
SpO_2 (%)	Before	98.11±1.40	0.429	98.31±1.56	0.810	98.10±1.88	0.465
	After	97.70±2.05		98.42±0.83		97.55±2.37	

Data are presented as mean ± SD. p-values are from paired t-test (two-tailed).
** Statistically significant ($p<0.05$).*
DSS=Dyang sensory stimulation; FR=foot reflexology; GCS=Glasgow Coma Scale; SBP=systolic blood pressure; DBP=diastolic blood pressure; SpO_2=peripheral oxygen saturation.

Table 3. Mean change scores (day 7 minus day 0) and between-group comparisons of Glasgow Coma Scale components and physiological parameters

Variable	Mean change (day 7 − day 0)			ANOVA p	ANCOVA p†
	DSS	FR	Control		
Eye-opening	1.12±1.054	0.74±1.32	1.00±0.50	0.263	0.336
Verbal response	0.24±0.562	0.26±0.733	0.15±0.366	0.813	0.813
Motor response	0.47±2.09	1.26±1.44	0.55±1.23	0.261	0.661
Total GCS	1.82±2.85	2.26±2.80	1.20±1.82	0.420	0.602
Heart rate (bpm)	−0.35±20.1	−8.00±23.4	−7.25±19.4	0.495	0.803
SBP (mmHg)	−2.94±27.3	−14.32±19.6	−3.45±31.5	0.344	0.545
DBP (mmHg)	−1.47±18.8	−1.68±16.0	2.45±18.4	0.718	0.908
Body temp (°C)	0.02±0.73	−0.17±0.91	−1.43±0.12	0.531	0.397
SpO_2 (%)	−0.41±2.09	0.11±1.88	−0.55±3.30	0.703	0.320

Data are presented as mean ± SD of change (post-intervention minus pre-intervention).
† ANCOVA adjusted for baseline GCS score, age, and primary diagnosis.
DSS=Dyang sensory stimulation; FR=foot reflexology; GCS=Glasgow Coma Scale; SBP=systolic blood pressure; DBP=diastolic blood pressure; SpO_2=peripheral oxygen saturation.

Discussion

This study found that both DSS and FR produced significant within-group GCS improvements over seven days, although neither demonstrated statistically significant superiority over standard ICU care in between-group analyses. The similarity in within-group improvements across arms, including the control group, is consistent with spontaneous neurorecovery during the acute phase and the provision of routine care to all participants.

The significant within-group SBP reduction in the FR group is consistent with its proposed autonomic modulatory mechanism plantar mechanoreceptor activation reducing sympathetic tone and augmenting parasympathetic activity[11,12]. Bahonar et al. reported similar immediate hemodynamic effects following FR[14], and Shahsavari et al. documented significant SBP reductions after FR in bronchoscopy candidates[22]. The lack of significance between the groups for SBP can be attributed to the similarity in background sympathetic modulation of all three groups due to conventional nursing care methods (e.g., repositioning, contact during nursing care), and possibly to the two-hour assessment period after the session, since some of the FR effects on hemodynamic parameters were already diminished at that time. Research studies exploring the immediate effects of intervention have demonstrated more pronounced physiological changes[20,23].

Pathways for both DSS and FR are considered to be mechanistically based. DSS achieves activation of convergent multimodal ARAS pathways via sequential integration of afferent signals from different modalities. FR modifies both neuroendocrine and autonomic pathways through cutaneous reflex areas. On the contrary, it has been suggested that the lack of superiority between groups relating to GCS does not mean the absence of a biological impact; rather, it is possible to consider it the result of limitations in dose and duration, as well as a reason behind spontaneous recovery in the acute phase and decreased physiological response due to the use of medications with vasoactive and sedative effects, as shown earlier[10]. Another variable is family-delivered stimulation. Previous studies have shown that the stimulation delivered by relatives had better results than that performed by researchers, which is associated with the fact that emotionally charged stimuli activate the affective-limbic pathway in patients, while this phenomenon cannot be achieved via standard research delivery[24-26].

The present study has several methodological strengths, including independently generated randomization sequences, allocation concealment, blinded outcome assessment and data analysis, a three-arm comparison, and a prespecified ANCOVA-adjusted primary analysis.

Limitations

This study has several limitations. First, the intervention lasted seven days, and each session lasted 10 minutes; the observed effect estimates and confidence intervals should therefore be interpreted as imprecise estimates of short-term effects, not proof of equivalence or absence of a clinically meaningful benefit. Larger studies with longer and/or more intensive protocols are needed. In addition to previously mentioned points, treatment given to the control group was just another instance of passive positioning plus range-of-motion exercises. Therefore, it is possible that tactile and proprioceptive input played a role in mitigating between-group differences. Also, measurements of physiology took place two hours after the last session, so transient peak hemodynamic effects of reflexology could have been missed, while immediate post-session measurements were not analyzed. Finally, the Glasgow Coma Scale is not able to detect subtle or specific neurobehavioral changes in cases of disorders of consciousness. In the future, it is better to employ validated measures like the Coma Recovery Scale-Revised (CRS-R)[27]. Fifth, the research was done in one location. Variations in ICU nurse-to-patient ratio and staffing and sedation and analgesia practices might influence the effectiveness of interventions and their generalization. Sixth, the study investigated patients with different causes of disorders of consciousness, possibly impacting the results.

Conclusion

Dyang sensory stimulation and foot reflexology were feasible nursing interventions associated with within-group improvements in consciousness among ICU patients with disorders of consciousness. However, neither intervention demonstrated statistically significant superiority over standard care in between-group analyses during the seven-day protocol. These findings should be interpreted in light of the modest sample size, short intervention duration, routine sensory input in the control group, and the limitations of GCS for detecting subtle changes. Larger multicenter trials with longer follow-up, clinically justified intervention doses, immediate and serial physiological measurements, and CRS-R assessment are warranted.

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Ethical assessment

This study was approved by the Kashan University of Medical Sciences Ethics Committee (Approval Number: IR.KAUMS.MEDNT.REC.1402.104; Approval Date: 2023-07-30) and registered in the Iranian Registry of Clinical Trials (IRCT20230903059339N1). Informed consent was obtained from the legal guardians/proxies of all participants. The study was conducted in accordance with the CONSORT 2010 Statement guidelines for reporting parallel group randomized trials.

Declaration of Generative AI and AI-assisted Technologies

During the preparation of this work the author(s) used AI-assisted technology for English language editing and structural formatting of this manuscript. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the accuracy, integrity, and originality of the work. All scientific content, data interpretation, and clinical conclusions were generated by the authors.

Authors' Contributions

Conceptualization: F.A., M.A.; Methodology/Study Design: N.M.A., M.A.; Supervision: M.A.; Resources/Study Materials and Equipment: F.A., S.R., K.Y.; Data Collection and/or Processing: F.A., S.R., K.Y.; Data Analysis and/or Interpretation: M.A.; Literature Review: F.A., M.A.; Writing: Original Draft Preparation: M.A., N.M.A.; Writing: Review and Editing/Critical Review: F.A., M.A., N.M.A.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

References

1. Gu J, et al. The effect of musical sensory orientation training in improving consciousness level in patients with disorders of consciousness: a pilot study. *Frontiers in neuroscience*. 2025; 19:1610811.
2. Abu Jebbeh R, Saleh MN, Alnaeem MM, Ghatasheh A. Effects of Integrated Sensory Stimulation on Consciousness and Cognitive Functions in ICU Patients: A Systematic Review. *Pal Med Pharm J*. 2025;11(1):47-54.
3. Abdelrahman AA, Mohammed ZA, Abdelaziz MA, Ahmed MAE. Assessment of Nurses' Knowledge and Practices Regarding Care of Patients with Diabetic Coma. *Assiut Scientific Nursing Journal*. 2020; 8:167-73.
4. Kondziella D, et al. Incidence and prevalence of coma in the UK and the USA. *Brain communications*. 2022;4: fcac188.
5. Edlow BL, et al. Therapies to Restore Consciousness in Patients with Severe Brain Injuries: A Gap Analysis and Future Directions. *Neurocritical care*. 2021; 35:68-85.
6. Barra A, Monti M, Thibaut A. Noninvasive Brain Stimulation Therapies to Promote Recovery of Consciousness: Where We Are and Where We Should Go. *Seminars in neurology*. 2022; 42:348-62.
7. Alashram AR, et al. Effects of sensory stimulation on level of consciousness in comatose patients after traumatic brain injury: A systematic review. *Physiotherapy Practice and Research*. 2021; 41:143-53.
8. Kumar S, Agarwal N, Sanal TS. Effectiveness of coma arousal therapy on patients with disorders of consciousness - A systematic review and meta-analysis. *Brain circulation*. 2024; 10:119-33.
9. Dang B, Chen W, He W, Chen G. Rehabilitation Treatment and Progress of Traumatic Brain Injury Dysfunction. *Neural plasticity*. 2017; 2017:1582182.
10. Mohammadi K, Ravari A, Mirzaei T. The Effect of Dyangs' Sensory Stimulation on the Level of Consciousness, Pain and Restlessness in the Patients under Mechanical Ventilation: A Clinical Trial Study. *SJKU*. 2022;27(4):79-92.
11. Embong NH, Soh YC, Ming LC, Wong TW. Revisiting reflexology: Concept, evidence, current practice, and practitioner training. *Journal of traditional and complementary medicine*. 2015; 5:197-206.
12. Jing Y, et al. The Effects of Foot Reflexology on Vital Signs: A Meta-Analysis of Randomized Controlled Trials. *Evidence-based complementary and alternative medicine: eCAM*. 2022; 2022:4182420.
13. Molavi Vardanjani M, Masoudi Alavi N, Razavi NS, Aghajani M, Azizi-Fini E, Vaghefi SM. A randomized-controlled trial examining the effects of reflexology on anxiety of patients undergoing coronary angiography. *Nurs Midwifery Stud*. 2013;2(3):3-9.
14. Bahonar E, Najafi Ghezeljeh T, Haghani H. Comparison of Single and Combined Effects of Nature Sounds and Foot Sole Reflexology Massage on the Level of Consciousness in Traumatic Comatose Patients: A Randomized Controlled Clinical Trial. *Holistic nursing practice*. 2019; 33:177-86.
15. Li J, Cheng Q, Liu FK, Huang Z, Feng SS. Sensory stimulation to improve arousal in comatose patients after traumatic brain injury: a systematic review of the literature. *Neurological sciences: official journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology*. 2020; 41:2367-76.
16. Moher D, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. *BMJ (Clinical research ed.)*. 2010;340:c869.
17. Boutron I, Altman DG, Moher D, Schulz KF, Ravaud P. CONSORT Statement for Randomized Trials of Nonpharmacologic Treatments: A 2017 Update and a CONSORT Extension for Nonpharmacologic Trial Abstracts. *Annals of internal medicine*. 2017; 167:40-7.
18. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet (London, England)*. 1974; 2:81-4.
19. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Indian journal of psychological medicine*. 2013; 35:121-6.

20. Vahedian-Azimi A, Ebadi A, Asghari Jafarabadi M, Saadat S, Ahmadi F. Effect of Massage Therapy on Vital Signs and GCS Scores of ICU Patients: A Randomized Controlled Clinical Trial. *Trauma monthly*. 2014;19: e17031.

21. Sayari S, Nobahar M, Ghorbani R. Effect of foot reflexology massage on physiological indices in patients with acute myocardial infarction. *Koomesh*. 2018; 20:469-77.

22. Shahsavari H, Abad MEE, Yekaninejad MS. The effects of foot reflexology on anxiety and physiological parameters among candidates for bronchoscopy: a randomized controlled trial. *Eur J Integr Med*. 2017; 12:177-81.

23. Salehi B, Azimian J, Yekefallah L, Mafi M. Effects of Foot Reflexology and Tactile Stimulation on Consciousness and Physiological Indicators of Traumatic Patients. *Caspian J Neurol Sci*. 2019;5(3):133-9.

24. Abbasi M, Mohammadi E, Sheaykh Rezayi A. Effect of a regular family visiting program as an affective, auditory, and tactile stimulation on the consciousness level of comatose patients with a head injury. *Japan journal of nursing science: JJNS*. 2009; 6:21-6.

25. Moattari M, Alizadeh Shirazi F, Sharifi N, Zareh N. Effects of a Sensory Stimulation by Nurses and Families on Level of Cognitive Function, and Basic Cognitive Sensory Recovery of Comatose Patients with Severe Traumatic Brain Injury: A Randomized Control Trial. *Trauma monthly*. 2016;21: e23531.

26. Ahmed FR, Attia AK, Mansour H, Megahed M. Outcomes of family-centred auditory and tactile stimulation implementation on traumatic brain injured patients. *Nursing open*. 2023; 10:1601-10.

27. Giacino JT, Kalmar K, Whyte J. The JFK Coma Recovery Scale-Revised: measurement characteristics and diagnostic utility. *Arch Phys Med Rehabil*. 2004;85(12):2020-9.