

Comparative Evaluation of the Effect of Aloe Vera Gel, Olive Oil, and Compound Aloe Vera Gel-Olive Oil on Prevention of Pressure Ulcer: A Randomized Controlled Trial

Abstract

Background: One of the most common problems in the intensive care units (ICUs) is pressure ulcers (PUs). The present study aimed to evaluate the effectiveness of aloe vera gel, olive oil, and compound aloe vera gel-olive oil in the prevention of PUs. **Materials and Methods:** This randomized clinical trial was conducted on 240 patients. They were randomly divided into four groups, aloe vera gel ($n = 60$), olive oil ($n = 60$), aloe vera gel-olive oil combination ($n = 60$), and control ($n = 60$). Braden scale and National Pressure Ulcer Advisory Panel scale were used to collect data. The intervention was performed for 30 days. In the intervention and control groups, the patient received routine care. In each intervention group, 10–15 ml of olive oil or aloe vera gel or a combination of olive oil and aloe vera was rubbed into body areas under pressure. **Results:** There were no PUs detected in all groups before the intervention; after the intervention, 12 patients in the olive group, 20 patients in the aloe vera group, 10 patients in the aloe vera-olive combination group, and 22 patients in the control group developed PUs. The results reported 40% of the patients with stage 1 PU and 10% of them with stage 2. **Conclusion:** Due to the effectiveness of olive oil and aloe vera-olive oil combination in preventing PU, it is recommended to use these herbal compounds in preventing PU on ICU patients.

Keywords: Aloe vera gel, olive oil, pressure ulcer, prevention

Introduction

A pressure ulcer (PU) is a localized injury on the bony prominence caused by pressure and shearing^[1,2] Risk factors for PUs include immobility, malnutrition, incontinence, aging, and chronic diseases.^[3,4] Findings indicated that the prevalence and incidence of these wounds are various in different countries.^[4] Its prevalence was reported to average 10.8% in Europe and 22%–44% in the intensive care unit (ICU) of the United States (US) hospitals.^[5,6] The incidence of these wounds in the ICU of South Korean hospitals was 5.9%.^[7] In Iran, the prevalence of PUs was reported to be 5% in general wards and 21%–1.10% in the ICUs.^[2] One of the major health problems is PU leading to increased hospitalization time, pain, infection, chronic wounds, sepsis, and death.^[2,8–10] Treatment of PUs is costly so that spent annually 11 and 4.1 billion dollars in the US and the United Kingdom, respectively.^[2,11–13] In the study of Zarei *et al.*, it was found that the direct costs of

the treatment of PUs in Iran were estimated from 12 dollars for stage 1, 67 thousand dollars for PUs stage 4.^[14] Therefore, due to the high prevalence and high financial and human costs of PUs, early treatment and prevention of its occurrence is one of the most important goals of the health care systems.^[2,4,8,12] Among the most important methods of preventing PUs are risk factor assessment, alternating pressure mattress, change position, proper nutrition, observe skin hygiene, applying dressings to prevent PUs such as films, hydrocolloid, foams, topical agents, and application of emollients and hydrating products.^[2,8,10,15,16] The most common of these strategies in Iran is to observe the patient's skin hygiene, proper nutrition, change position, pressure relief mattress, and prevention of skin damage. Despite these measures, many Iranian patients still suffer from PUs.^[15,17] These days, one of the most widely used products for the prevention of PUs in the developed countries is essential fatty acids like hyper-oxygenated fatty acids (HOFA), such

Masoud Fallahi^{1,2},
Ali Soroush²,
Narges Sadeghi³,
Feizollah Mansouri²,
Tofigh Mobaderi⁴,
Somayeh
Mahdavian¹,

¹School of Nursing and Midwifery, Kermanshah University of Medical Sciences, ²Clinical Research Development Center, Imam Reza Hospital, Kermanshah University of Medical Sciences, ³Student Research Committee, Kermanshah University of Medical Sciences, Kermanshah, ⁴Department of Biostatistics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran

Address for correspondence:

Mrs. Somayeh Mahdavian,
School of Nursing and
Midwifery, Kermanshah
University of Medical Sciences,
Kermanshah, Iran,
E-mail: smahdavia@gmail.
com

Received: 17 May 2021

Revised: 01 July 2021

Accepted: 01 August 2021

Published: 31 January 2022

Access this article online

Website: www.advbiores.net

DOI: 10.4103/abr.abr_121_21

Quick Response Code:



How to cite this article: Fallahi M, Soroush A, Sadeghi N, Mansouri F, Mobaderi T, Mahdavian S. Comparative evaluation of the effect of aloe vera gel, olive oil, and compound aloe vera gel-olive oil on prevention of pressure ulcer: A randomized controlled trial. *Adv Biomed Res* 2022;11:6.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

as mepentol, corpitol, and linovera. One of the alternatives to these compounds is olive oil which is more accessible and more affordable than HOFA.^[12,18] Olive oil is one of the medicinal plants that, due to its uncomplicated and many healing properties, has attracted the attention of many researchers.^[8,11] Olive oil is rich in essential fatty acids oleic acid, linoleic acid, phytosterol, and squalene, which increase hydration, skin protection, and skin regeneration.^[8] On the other hand, the phenolic compounds in olive oil have antimicrobial, anti-inflammatory, and antioxidant properties, causing tissue coverage and thus accelerating wound healing.^[11] Studies showed that topical use of olive oil in the prevention of PUs is as effective as HOFA solutions.^[8,12] Another medicinal plant that has been used to treat skin problems since 1500 BC is aloe vera which is one of 360 species of Aloe plant.^[2,19-21] The presence of glucomannan in aloe vera, which is rich in polysaccharide mannose is known to increase fibroblast proliferation and the production of hyaluronic acid and hydroxyproline in fibroblasts so that accelerates wound healing.^[2,21] In addition, mucopolysaccharides, amino acids, and zinc found in aloe vera are involved in maintaining integrity and preventing skin ulcers.^[22] Various studies have shown that the combination of olive oil and aloe vera improves skin lesions caused by sulfur mustard, atopic dermatitis, and chronic wounds.^[22-26] Therefore, it is likely that this combination could also be positive on the prevention and control of PUs. Since the prevention and control of PUs is one of the most important priorities of the care system in any country^[2,4,5] and due to the effect of herbal compounds in wound control, low cost and minimal side effects^[2,8,22,25] and considering the limited number of studies on the field,^[24] the present study was conducted to compare the common methods of preventing PUs with olive oil and aloe vera.

Materials and Methods

Trial design

This randomized controlled clinical trial was conducted with a parallel design and 1:1 allocation ratio in the experimental (including three groups of intervention) and control groups. This study was based on the consolidated standards of reporting trials (CONSORT) Guideline and lasted for 1 year, from November 2019 to December 2020.

Sample and sampling method

The samples included all hospitalized patients with moderate- to high-risk of PUs based on the Braden Scale with no PUs in the ICUs of Imam Reza Hospital in Kermanshah-Iran, who were selected through convenience sampling method and block randomization method in one of three intervention groups and a control group. Blocking was performed as follows: The experimental groups with olive oil, aloe vera gel, and the compound of aloe vera gel-olive oil were assigned

with codes A, B, and C, respectively, and the control group received code D. The study block included ABCD, ABDC, ADBC, ADCB, ACBD, ACDB, BACD, BADC, BCAD, BCDA, BDCA, BDAC, CABD, CADB, CBAD, CBDA, CDAB, CDBA, DABC, DACB, DBCA, DBAC, DCAB, and DCBA, where the ABCD block was selected as the first block. This method continued until the samples were completed. The minimum sample size was calculated based on the same study with 95% of the level of confidence and 80% testability, 240. To increase the testability and achieve more valid results, finally, 60 people in each group were included in the study. They remained in the study and no sample was excluded from the study. Inclusion criteria included hospitalization in the ICU without PU by the National Pressure Ulcer Advisory Panel (NPUAP) scale on the 1st day of hospitalization, stability of hemodynamic status, having a foley catheter, obtaining a score of 9–14 from Braden Scale (moderate-to-high risk), no Diarrhea, serum Albumin above 3.5 g/dl, no edema, patient consent to participate in the study, insensitivity to olive oil and aloe vera gel, no autoimmune diseases, renal failure and diabetes, no use of immunosuppressive drugs, no vascular disease, age over 18 years, and no smoking. Exclusion criteria included reluctance to continue cooperation, need for surgery, scoring 19 and above from the Braden Scale during wound examination, discharge, and death.

Measurement instrument

Sociodemographic questionnaire, clinical information questionnaire, and Braden Scale and NPUAP scale were used to collect the data. Sociodemographic questionnaire included questions related to age, gender, level of consciousness, and body mass index (BMI). Clinical information questionnaire included Braden score type, occurrence of PUs, stage of PUs, and location of PUs. The validity of the sociodemographic and clinical information questionnaires was assessed based on the content validity method. For this purpose, the questionnaires were distributed among 12 faculty members of the nursing ($n = 6$) and dermatology ($n = 6$) group, and their comments were considered in revising the questionnaires. The Braden scale was used to assess the risk of PUs. Braden scale was introduced by the International Pressure Wound Association. The internal consistency of the questionnaire using Cronbach's alpha was reported 0.72.^[27] The validity of this tool was confirmed in national and international studies.^[2,28] This tool includes 6 subsets, sensory perception, humidity, activity, mobility, nutrition, and friction. It uses a 3-or 4-point scale, and the total score ranges from 6 to 23. Lower scores indicate greater risk of PU development.^[2,28,29]

NPUAP scale was used to classify PUs into six stages. Stage 1 (nonblanchable redness to the skin). Stage 2

(a break in the dermis of the skin). Step 3 (full-thickness skin loss, in which adipose is visible). Stage 4 (is the complete destruction of the skin, ligament, fascia, muscle, tendon, or bone appears). Unstageable PU (full-thickness skin and tissue loss in which the extent of tissue damage within the ulcer cannot be confirmed because it is obscured by slough or eschar). Deep tissue injury (skin may be intact or not intact, but the skin has a purple maroon discoloration over a pressure point).^[9,30-33]

Interventions

After obtaining approval from the University Ethics Committee, the researcher (first author) referred to Imam Reza hospital for sampling. First, the objectives of the study were explained to the patients or their families then they were included in the study. In the aloe vera group, 94% aloe vera gel and in the olive

oil group, 100% pure olive oil were made by Barij Essence Pharmaceutical Company (Yasuj, Iran). In the aloe vera gel-olive oil group, a compound of aloe vera gel-olive oil was used in a ratio of 3-2.^[23,24] Sampling lasted 30 days.^[24,34] So that in the intervention groups three times a day (every 8 h) at amount of 10–15 ml of each one, gently without pressure was applied on the pressure areas. Furthermore in the intervention and control groups, the patient received routine care including to observe the patient’s skin hygiene, proper nutrition, change position, pressure relief mattress, and prevention of skin damage then pressurized areas were examined daily by NPUAP scale. It should be noted that, this study was double-blind because the patients’ level of consciousness was low (Glasgow coma scale [GCS] = 8–10) and the intervening researcher (first author) and evaluator (second author) were different. The study process is shown in Figure 1.

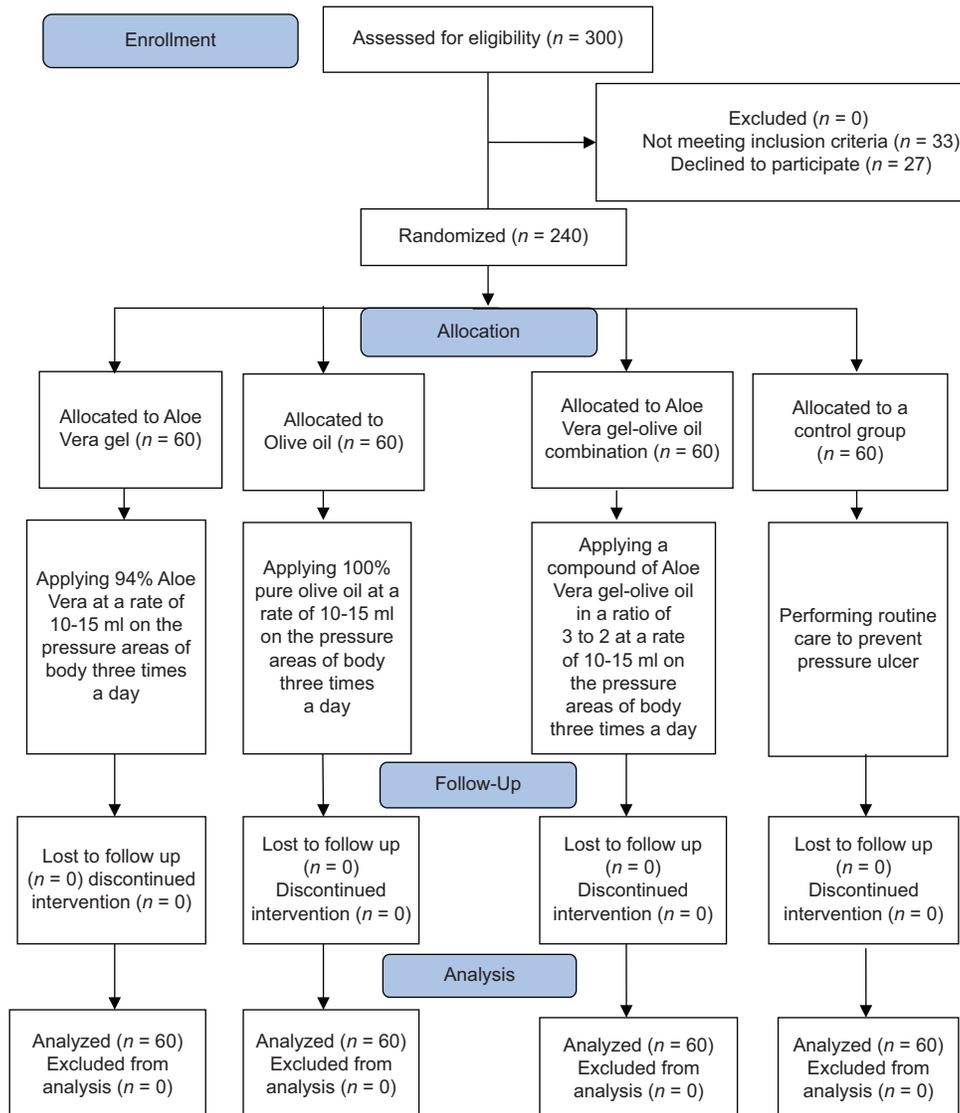


Figure 1: The CONSORT diagram of the study

Statistical methods

Data were analyzed using the Statistical Package for the Social Sciences (SPSS v. 18.0; SPSS Inc., Chicago, IL, USA). The distribution of the studied variables was examined by the Kolmogorov-Smirnov test (KS test) and the results showed a normal distribution ($P < 0.001$). Therefore, nonparametric methods such as Kruskal–Wallis H -test and Chi-square were used. Chi-square test was also used to determine whether the groups were homogenous in terms of nominal variables such as gender, and Kruskal–Wallis H -test was also used to determine whether the groups were homogenous in terms of quantitative variables. Furthermore, to evaluate the effect of each variable on the incidence of PUs, the simple logistic regression model was used. It should be noted that the independent variables of group type and gender, as nominal qualitative variables, entered the simple logistic regression model as a dummy variable. In the group variable, the control group was considered the reference group to be compared with other groups, and in the gender variable, men were considered a reference to compare women with men.

Ethical considerations

This trial was conducted in accordance with the Declaration of Helsinki. The Ethics Committee of KUMS endorsed the study protocol with reference number IR.KUMS.REC.1396.477. The study was also registered at the Iranian Registry of Clinical Trials under the code

IRCT20181105041563N4. Before the study, the objectives and methods were explained to all of the participants, and they were assured that their responses would remain confidential. Written informed consent was obtained from all the participants before the study.

Results

In this study, 240 patients were divided into three intervention groups and one control group and a control group (60 patients in each group). About 50.8% of the patients ($n = 122$) were female and mean age of the samples was 13.24 ± 56.26 years. Furthermore, the mean BMI and Braden score were 26.96 ± 1.72 Kg/m² and 11.29 ± 1.16 , respectively. There were no PUs detected in all groups before the intervention; after the intervention, 12 patients in the olive group (20%), 20 patients in the aloe vera group (33.3%), 10 patients in the aloe vera-olive group (16.7%), and 22 patients in the control group (36.7%) developed PUs, which was statistically significant ($P < 0.001$). Out of 64 patients (26.7%) who developed PUs, 40 patients (62.5%) suffered from stage 1. So that 31 (48.4%) had ulcers in the sacrum. The mean duration of ulcers was 8.12 ± 3.33 in general [Table 1].

There was observed that the regression coefficients for the olive, aloe vera, and aloe vera-olive groups were -0.84 , -0.15 , and -1.06 , respectively, and the odds ratio were estimated 0.43, 0.86, and 0.34, respectively. Considering

Table 1: Comparison of the demographic variables in the study groups

Variables	Groups				P
	Olive	Aloe vera	Aloe vera + olive	Control	
Age (years)	57.13±14.98	52.97±11.24	55.30±11.52	59.67±14.22	0.01 ^{s,#}
BMI (kg/m ²)	26.75±1.70	27.28±1.70	27.10±1.84	27.73±1.61	0.27 ^{*,#}
GCS score ^d	8.83±0.69	8.68±0.79	8.78±0.74	8.95±0.81	0.26 ^{*,#}
Braden score ^a	11.37±1.21	11.47±1.08	11.33±1.22	11.02±1.11	0.14 ^{*,#}
Gender (%)					
Male	29 (48.3)	29 (48.3)	34 (56.7)	26 (43.3)	0.53 ^{*,†}
Female	31 (51.7)	31 (51.7)	26 (43.3)	34 (56.7)	
Incidence [@] (%)					
No	48 (80)	40 (66.7)	50 (83.3)	38 (63.3)	0.03 ^{s,†}
Yes	12 (20)	20 (33.3)	10 (16.7)	22 (36.7)	
If yes, wound grade (%)					
Stage I	9 (15)	13 (21.6)	8 (13.3)	10 (16.6)	0.18 ^{*,†}
Stage II	3 (5)	7 (11.6)	2 (3.3)	12 (20)	
Wound location (%)					
Sacrum	5 (8.3)	9 (14.9)	3 (5)	14 (23.3)	0.31 ^{*,#}
Buttock	5 (8.3)	6 (9.9)	6 (10)	7 (11.6)	
Iliac	2 (3.3)	5 (8.3)	1 (1.6)	1 (1.6)	
Day ^b (%)					
6-4	0	7 (11.6)	0	11 (18.3)	0.01 ^{s,#}
9-7	9 (15)	8 (13.3)	3 (5)	5 (8.3)	
12-10	3 (5)	5 (8.3)	7 (11.6)	6 (10)	

*Nonsignificant, ^sSignificant, [†]Based on Chi-square test, [#]Based on Kruskal-Wallis H test, ^aTo assess PU risk, ^bThe interval between the start of the intervention and the occurrence of PUs, ^dGCS score: To assess the patient's level of consciousness, [@]Incidence: The number of patients developing new PUs during a sampling time (Grade I-IV). GCS: Glasgow Coma Scale, BMI: Body mass index, PUs: Pressure ulcers

the odds ratio in each group, it can be said that, on average, the incidence of PUs in the olive, aloe vera, and the combination of the two was 0.43, 0.86, and 0.34 times higher than the control group, respectively. The probability value was significant for olive and aloe vera-olive groups, though not significant for the aloe vera group at the level of 0.05. According to the odds ratio, it can be understood that for an increase of 1 year of age, the odds ratio increased the incidence of PUs by an average of 1.03 times. According to the odds ratio, the incidence of PUs in men was 1.23 times higher than in women; however, it was not statistically significant. The effect of BMI and GCS on the incidence of PU was not significant, but the effect of the Braden Scale was significant at the level of 0.05. The odds ratio for the Braden scale score was estimated to be 0.28, indicating that for every unit increase in the Braden scale, the probability of developing an average PU was 0.28 [Table 2].

Discussion

The aim of this clinical trial was to compare the effect of aloe vera gel, olive oil, and the combination of aloe vera gel-olive oil on the prevention of PUs. In the present study, after intervention with olive oil and aloe vera gel, 20% and 33.33% of the patients developed PUs, respectively. This rate was 16.7% in the aloe vera-olive combination group and 36.7% in the control group. The results of the present study suggested a significant effect of olive oil and the combination of aloe vera-olive oil on the prevention of PUs in these patients. Consistent with the results of this study, Karimi *et al.* indicated the positive effect of olive oil in the prevention of PU.^[35] Madadi *et al.* and Paymard *et al.* (2017) showed a positive effect of olive oil in the prevention of PU in ICU patients.^[36,37] It should be noted that, this product is cheap and available to patients who based on the available evidence, can prevent the incidence, prevalence and occurrence of PUs.^[38] Furthermore, the results of some studies showed that olive oil has positive effect on the treatment of diabetic foot ulcers, burn wounds,

and diaper dermatitis in children.^[34,39,40] Although the direct mechanism of action of olive oil in the prevention of PUs is not fully understood, some evidence suggests that olive oil causes skin hydration, elasticity, prevents skin rupture, improves circulation, and anti-inflammatory properties.^[8]

Some studies have shown that aloe vera gel is effective in preventing PUs.^[2,22,25] Hekmatpou *et al.* examined the effect of aloe vera gel compare to gels containing starch and water on the prevention of PUs which showed the positive effect of aloe vera gel on the prevention of PU stage one.^[2] Baghdadi *et al.* showed the effectiveness of aloe vera gel in reducing the incidence of PUs in the sacrum.^[22] However, in the present study, aloe vera alone showed no effects on the prevention of PUs. In explaining this difference, it could be said that in the present study, unlike Hekmatpou *et al.* and Baghdadi *et al.* 94% of aloe vera gel was used and also no dressing was applied on aloe vera. On the other hand, the variety of aloe vera species and different methods of its preparation were among the most important reasons for the difference in the result.^[2,22] One of the most important disadvantages of aloe vera is the lack of durability on the skin surface because according to the evidence, 99% of aloe vera gel is water, which stays on the surface of the skin for a short time.^[2,23,24] Since the olive oil has greasy characterize, maintains skin moisture, and leads to increased hydration in the stratum corneum, it seems that the combination of olive-aloe vera not only adds the properties of olives to aloe vera but also makes this compound more durable on the skin. Because it may have moisturizing, emollient, anti-inflammatory, antioxidant, antifungal, and immunomodulatory activities properties.^[23,24,26]

The results of the present study suggested a significant effect of the combination of aloe vera-olive oil on the prevention of PUs in these patients. Panahi *et al.*, who investigated its effect in comparison to phenytoin in the treatment of chronic wounds, showed that the combination had a greater effect in the acceleration of wound healing.^[24] It is important to note that phenytoin has side effects such as generalized rash, and over granulation tissue while it is believed that natural products have fewer side effects compared with synthetic drugs.^[24] In another study, Panahi *et al.*, showed the positive effect of the combination of olive oil and aloe vera in reducing of pruritus, burning sensation and scaling, like betamethasone 0.1%. In addition, decreased fissure and excoriation were reported only in the group receiving the combination of aloe vera and olive oil.^[23] It should be noted that long-term use of corticosteroids is not recommended due to their serious side effects such as skin atrophy, telangiectasia, acne and hypertension, and osteoporosis.^[23] Panahi *et al.* indicated that the effect of the combination of aloe vera and olive oil on the treatment of atopic dermatitis was greater than betamethasone.^[26] In the three articles mentioned above,^[23,24,26] examined the effect of phenytoin, betamethasone, and the combination of olive

Table 2: Simple logistic regression results

Variable	B	SE	OR	P
Group				
Olive	-0.840	0.4194	0.432	0.045
Aloe vera	-0.147	0.3831	0.864	0.702
Aloe vera + olive	-1.063	0.4379	0.345	0.015
Control	Reference	-	-	-
Age	0.029	0.0118	1.030	0.013
Gender				
Female	0.211	0.2929	1.235	0.472
Male	Reference	-	-	-
BMI	0.044	0.0849	1.045	0.602
Braden score	-1.269	0.2045	0.281	0.000
GCS	0.366	0.1917	1.442	0.056

SE: Standard error, OR: Odds ratio, BMI: Body mass index, GCS: Glasgow Coma Scale

oil and aloe vera gel on wound healing but in the literature review, no study was found that examined the combination of aloe vera and olive oil in the prevention of PUs, though. In the present study, 26.7% of the patients developed PUs, of which 16.7% were stage 1 and 10% were stage 2. No stages 3 and 4 were observed. Furthermore, the incidence of stage 1 in olive, aloe vera, combination, and control groups was 15%, 21.6%, 13.6%, and 16.6%, respectively. Pressure ulcer in the intervention and control groups did not show a statistically significant difference. In addition, in this study, most of the wounds were in the sacrum and buttock. The results did not show a statistically significant difference between the locations of the PU in the studied groups. In the present study, the findings indicated that most patients developed PUs between 7 and 9 days, so that the mean duration of PUs in the olive, aloe vera, and combination groups were 9.16 ± 0.57 , 7.7 ± 2.25 , and 9.3 ± 1.03 days and in the control group it was 7.18 ± 3.03 days. The results of the present study showed a significant relationship between the duration of PU occurrence between the intervention and control groups, and in control and aloe vera groups, patients suffered from PUs in a shorter time compared to the olive group and the combination of aloe vera and olive. Madadi *et al.*, focusing on the effect of olive oil on the prevention of PUs in patients admitted to the ICU, 16% of the patients in the olive oil group faced PUs after an average of 18.73 ± 5.36 days while 40% of the patients in the control group developed PUs with a mean time of 15.46 ± 7.40 days as well as in intervention group, 13.3% of the patients developed stage 1 PUs, and 3.3% of the patients developed stage 2 PUs. In the control group, 10% of the patients developed stage 1 PU and 30% of the patients developed stage 2 PU.^[36] In another study by Paymard *et al.* (2017), findings in the intervention group showed that 14.2% of the patients developed PUs and in the control group 34.2% of the patients developed PUs.^[37] Díaz-valenzuela *et al.* showed that 4.18% of the patients in the olive oil group developed PUs (stage 1) of which 55% of the patients in the sacrum, 36% of the patients in heel, and 9% of the patient developed PUs in the buttock. In the HOFA group, 6.57% of the patients developed stage 1 PUs, of which 61% in sacrum, 33% in heel, and 1 in malleolus developed ulcers.^[8]

Limitation

The present study was performed in the ICU, therefore the results may not be generalizable to the patients in all wards and it is suggested that further studies in this field be done.

Conclusion

Due to the effectiveness of olive oil and aloe vera-olive oil combination in preventing PU, it is recommended to use these herbal compounds in preventing PU on ICU patients. It is also suggested that future studies be performed on the patients who hospitalized in other wards.

Availability of data and materials

The identified datasets analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgments

The authors would like to appreciate all the patients who participated in the study. We highly appreciate the Clinical Research Development Center of Imam Reza Hospital for kindly advices.

Financial support and sponsorship

The study was funded by Kermanshah University of Medical Sciences (Grant NO. 96620).

Conflicts of interest

There are no conflicts of interest.

References

1. Ho C, Jiang J, Eastwood CA, Wong H, Weaver B, Quan H. Validation of two case definitions to identify pressure ulcers using hospital administrative data. *BMJ Open* 2017;7:e016438.
2. Hekmatpou D, Mehrabi F, Rahzani K, Aminiyan A. The effect of aloe vera gel on prevention of pressure ulcers in patients hospitalized in the orthopedic wards: A randomized triple-blind clinical trial 11 Medical and Health Sciences 1103 Clinical Sciences. *BMC Complement Altern Med* 2018;18:1-11.
3. Nicksic PJ, Sasor SE, Tholpady SS, Wooden WA, Gutwein LG. Management of the pressure injury patient with osteomyelitis: An algorithm. *J Am Coll Surg*. 2017;225:817-22.
4. Etafa W, Argaw Z, Gemechu E, Melese B. Nurses' attitude and perceived barriers to pressure ulcer prevention. *BMC Nurs*. 2018;17:14.
5. Moore Z, Avsar P, Conaty L, Moore DH, Patton D, O'Connor T. The prevalence of pressure ulcers in Europe, what does the European data tell us: A systematic review. *J Wound Care*. 2019;28:710-9.
6. Cramer EM, Seneviratne MG, Sharifi H, Ozturk A, Hernandez-Boussard T. Predicting the incidence of pressure ulcers in the intensive care unit using machine learning. *EGEMS (Wash DC)* 2019;7:49.
7. Han Y, Jin Y, Jin T, Lee SM, Lee JY. Impact of pressure injuries on patient outcomes in a Korean hospital: A case-control study. *J Wound Ostomy Continence Nurs* 2019;46:194-200.
8. Díaz-Valenzuela A, García-Fernández FP, Carmona Fernández P, Valle Cañete MJ, Pancorbo-Hidalgo PL. Effectiveness and safety of olive oil preparation for topical use in pressure ulcer prevention: Multicentre, controlled, randomised, and double-blinded clinical trial. *Int Wound J*. 2019;16:1314-22.
9. Hajhosseini B, Longaker MT, Gurtner GC. Pressure injury. *Ann Surg* 2020;271:671-9.
10. Mervis JS, Phillips TJ. Pressure ulcers: Prevention and management. *J Am Acad Dermatol*. 2019;81:893-902.
11. Miraj S, Pourafzali S, Ahmadabadi ZV, Rafiei Z. Effect of olive oil in preventing the development of pressure ulcer grade one in intensive care unit patients. *Int J Prev Med* 2020;11:23.
12. Lupiáñez-Pérez I, Herrera J, Kaknani S, Lupiáñez-Pérez Y, Fernández-Gallego M, Martín-Santos F, *et al.* A cost minimisation analysis of olive oil versus hyperoxygenated fatty

- acid treatment for the prevention of pressure ulcers in primary health care: A randomised controlled trial. *Wound Repair Regen* 2017;25:846-51.
13. Padula WV, Delarmente BA. The national cost of hospital-acquired pressure injuries in the United States. *Int Wound J* 2019;16:634-40.
 14. Zarei E, Madarshahian E, Nikkha A, Khodakarim S. Incidence of pressure ulcers in intensive care units and direct costs of treatment: Evidence from Iran. *J Tissue Viability*. 2019;28:70-4.
 15. Moghadari M, Rezvanipour M, Mehrabani M, Ahmadinejad M, Tajadini H, Hashempour MH. Efficacy of mummy on healing of pressure ulcers: A randomized controlled clinical trial on hospitalized patients in intensive care unit. *Electron Physician*. 2018;10:6140-7.
 16. Dehghani M, Azarpira N, Mohammad Karimi V, Mossayebi H, Esfandiari E. Grafting with cryopreserved amniotic membrane versus conservative wound care in treatment of pressure ulcers: A randomized clinical trial. *Bull Emerg Trauma* 2017;5:249-58.
 17. Babamohamadi H, Ansari Z, Nobahar M, Mirmohammadkhani M. The effects of peppermint gel on prevention of pressure injury in hospitalized patients with head trauma in neurosurgical ICU: A double-blind randomized controlled trial. *Complement Ther Med* 2019;47:102223.
 18. Pérez-Acevedo G, Torra-Bou JE, Manzano-Canillas ML, Bosch-Alcaraz A. Management of purpura fulminans skin lesions in a premature neonate with sepsis: A case study. *J Wound Care*. 2019;28:198-203.
 19. Shakib Z, Shahraki N, Razavi BM, Hosseinzadeh H. Aloe vera as an herbal medicine in the treatment of metabolic syndrome: A review. *Phytother Res*. 2019;33:2649-60.
 20. Salehi B, Albayrak S, Antolak H, Kręgiel D, Pawlikowska E, Sharifi-Rad M, Uprety Y, Tsouh Fokou PV, Yousef Z, Amiruddin Zakaria Z, Varoni EM, Sharopov F, Martins N, Iriti M, Sharifi-Rad J. Aloe genus plants: From farm to food applications and phytopharmacotherapy. *Int J Mol Sci* 2018;19:2843.
 21. Gao Y, Kuok KI, Jin Y, Wang R. Biomedical applications of aloe vera. *Crit Rev Food Sci Nutr*. 2019;59(Supp 1):S244-56.
 22. Baghdadi M, Rafiei H, Rashvand F, Oveisi S. Effect of aloe vera gel, *Calendula officinalis* ointment and simple prophylactic sacral dressings for pressure injury development. *Chronic Wound Care Manag Res* 2020;7:19-26.
 23. Panahi Y, Davoudi SM, Sahebkar A, Beiraghdar F, Dadjo Y, Feizi I, Amirchoopani G, Zamani A. Efficacy of aloe vera/olive oil cream versus betamethasone cream for chronic skin lesions following sulfur mustard exposure: A randomized double-blind clinical trial. *Cutan Ocul Toxicol* 2012;31:95-103.
 24. Panahi Y, Izadi M, Sayyadi N, Rezaee R, Jonaidi-Jafari N, Beiraghdar F, Zamani A, Saebkar A. Comparative trial of aloe vera/olive oil combination cream versus phenytoin cream in the treatment of chronic wounds. *J Wound Care* 2015;24:459-60, 462-5.
 25. Hekmatpou D, Mehrabi F, Rahzani K, Aminiyan A. The effect of aloe vera clinical trials on prevention and healing of skin wound: A systematic review. *Iran J Med Sci* 2019;44:1-9.
 26. Panahi Y, Rastgar N, Zamani A, Sahebkar A. Comparing the therapeutic effects of aloe vera and olive oil combination cream versus topical betamethasone for atopic dermatitis: A randomized double-blind clinical trial. *J Pharmacopuncture*. 2020;23:173-8.
 27. Lima-Serrano M, González-Méndez MI, Martín-Castaño C, Alonso-Araujo I, Lima-Rodríguez JS. Predictive validity and reliability of the Braden scale for risk assessment of pressure ulcers in an intensive care unit. *Med Intensiva (Engl Ed)*. 2018;42:82-91.
 28. Chen HL, Cao YJ, Zhang W, Wang J, Huai BS. Braden scale (ALB) for assessing pressure ulcer risk in hospital patients: A validity and reliability study. *Appl Nurs Res* 2017;33:169-74.
 29. Aloweni F, Lim ML, Chua TL, Tan SB, Lian SB, Ang SY. A randomised controlled trial to evaluate the incremental effectiveness of a prophylactic dressing and fatty acids oil in the prevention of pressure injuries. *Wound Pract Res* 2017;25:24-34.
 30. Laryea EA. An Online Mixed-Methods Study Assessing Nurses' Training, Attitudes, Knowledge, Skill/Ability, and Perceived Barriers with Regard to Adherence to the National Pressure Ulcer Advisory Panel's Clinical Practice Guidelines. Teachers College, Columbia University; 2019.
 31. Kottner J, Cuddigan J, Carville K, Balzer K, Berlowitz D, Law S, Litchford M, Mitchell P, Moore Z, Pittman J, Sigauco-Roussel D, Yee CY, Haesler E. Pressure ulcer/injury classification today: An international perspective. *J Tissue Viability* 2020;29:197-203.
 32. Borzou SR, Amiri S, Azizi A, Tapak L, Rahimi Bashar F, Moradkhani S. Topical almond oil for prevention of pressure injuries: A single-blinded comparison study. *J Wound Ostomy Continence Nurs* 2020;47:336-42.
 33. Mervis JS, Phillips TJ. Pressure ulcers: Pathophysiology, epidemiology, risk factors, and presentation. *J Am Acad Dermatol*. 2019;81:881-90.
 34. Karimi Z, Behnammoghadam M, Rafiei H, Abdi N, Zoladl M, Talebianpoor MS, Arya A, Khastavaneh M. Impact of olive oil and honey on healing of diabetic foot: A randomized controlled trial. *Clin Cosmet Investig Dermatol* 2019;12:347-54.
 35. Karimi Z, Mousavizadeh A, Rafiei H, Abdi N, Behnammoghadam M, Khastavaneh M, Shahini S. The effect of using olive oil and fish oil prophylactic dressings on heel pressure injury development in critically ill patients. *Clin Cosmet Investig Dermatol*. 2020;13:59-65.
 36. Madadi Z, Zeighami R, Azimian J, Javadi A. The effect of topical olive oil on prevention of bedsore in intensive care units patients. *Int J Res Med Sci* 2015;3:2342-7.
 37. Paymard A, Salehian T, Behnammoghadam M, Abbas Ali Madadi Z, Shahnavazi A, Allahyari E, Bakhshi F, Ghaffarian Shirazi HR. The effect of local olive oil on prevention of pressure ulcers in patients hospitalized in the intensive care unit of Shahid Beheshti Hospital, Yasuj: A double-blind randomized clinical trial. *JAP* 2017;7:54-61.
 38. Poursadra E, Anvari-Tafti M, Dehghani A, Eghbali-Babadi M, Rafiei Z. Comparing the effect of henna oil and olive oil on pressure ulcer grade one in intensive care units patients. *Adv Biomed Res* 2019;8:68.
 39. Gurfinkel R, Palivatkel-Naim M, Gleisinger R, Rosenberg L, Singer AJ. Comparison of purified olive oil and silver sulfadiazine in the treatment of partial thickness porcine burns. *Am J Emerg Med* 2012;30:79-83.
 40. Sharifi-Heris Z, Farahani LA, Haghani H, Abdoli-Oskouee S, Hasanpoor-Azghady SB. Comparison the effects of topical application of olive and calendula ointments on Children's diaper dermatitis: A triple-blind randomized clinical trial. *Dermatol Ther* 2018;31:e12731.