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Acceleration of pressure ulcer healing in spinal cord injured patients using interrupted direct current

BOA Adegoke and KA Badmos

Physiotherapy Department, College of Medicine, University of Ibadan, Ibadan, Nigeria

Summary

This study was designed to investigate the efficacy of interrupted direct current (IDC) in augmenting routine nursing care in spinal cord injured (SCI) patients with pressure ulcers. Seven SCI patients aged 21 – 60 years (\bar{x} = 43.8, S.D. = 13.9) with grade IV pressure ulcers were randomly assigned to either a group receiving routine nursing care plus IDC stimulations or a group receiving routine nursing care plus placebo IDC. Patients in both groups received 45 minutes treatment thrice weekly for 4 weeks, and had their pressure ulcers measured for surface area on day 0, at 2 weeks and at 4 weeks of the study using standard method. Percentage changes in surface area were calculated for the two groups at the different time frames. Ulcers in the IDC group had 22.2% reduction in surface area while those in the placebo IDC group had a 2.6% reduction in surface area. The reduction in size was most evident in the first two weeks of the study. The results indicate that IDC stimulation may be used in conjunction with routine nursing care to accelerate healing of grade IV pressure ulcers in SCI injured patients.

Keywords: *Pressure ulcers, spinal cord injury, electrotherapy, electrical stimulation, wound healing, decubitus ulcers.*

Résumé

Cette étude avait été organisée pour investiguer l'efficacité du courant direct et ininterrompu (IDC) dans l'augmentation des soins infirmiers chez les patients ayant des accidents de la colonne vertébrale (SCI) et ayant des pressions ulcéreuses sept patients ayant des SCI, âge de 21 à 60 ans (\bar{X} =43.8, S.D. =13.9 ans) et présentant des pressions ulcéreuses de grade IV avaient été distribués au hasard soit dans un groupe recevant des soins infirmiers plus des stimulations d'IDC ou un groupe recevant des soins infirmiers plus des places d'IDC. Les patients dont les 2 groupes avaient reçu 45 minutes de traitement 3 fois par semaine pendant 4 semaines, ils avaient eu leur pression ulcéreuse mesurée pour les surfaces au jour 0, à 2 semaines et à 4 semaines de l'étude eu une réduction de 26% de réduction de la surface. La réduction en taille était plus évidente pendant les 2 premières semaines de l'étude. Ces résultats indiquent que la stimulation IDC pourrait être utilisée en conjonction avec les soins infirmiers de routine afin d'accélérer la guérison des pressions ulcéreuses de grade IV chez des patients ayant des accidents SCI.

Introduction

Pressure ulcers are a potentially serious complication in patients with spinal cord injury (SCI) and usually result in extended hospitalization, delay in rehabilitation and even hospital admission [1]. The actual incidence of pressure ulcers in patients with SCI has been put at 59% [2] and 41%,

[3] by various authors. The incidence in Nigerian hospitals is not available but may be as staggering if not worse. In SCI patients, pressure ulcers are slow in healing and expensive in management [4] such that the nursing cost is estimated to appreciate by as much as 50% when pressure ulcers develop [5]. Understandably, the management and attempt to accelerate the healing of pressure ulcers have been a multidisciplinary problem within the health sector.

Methods such as conventional nursing care, physical therapy modalities and surgery have been employed in pressure ulcer management. The physical therapy modalities that have been routinely employed include ultraviolet radiation [6,7], LASER [8], low intensity pulsed direct current [9,10] high voltage pulsed current [11] and therapeutic ultrasound [12]. The efficacy of the different therapeutic currents in accelerating the healing of ulcers and indolent wounds have been demonstrated, [1, 9, 10,12,13]. However, only the study by Griffin *et al.* [13] involved SCI patients as subjects. The present study was aimed at investigating the efficacy of interrupted direct current (IDC) in accelerating healing of pressure ulcers in SCI patients.

Method

Subjects: Seven patients aged 21-60 years with multiple pressure ulcers participated in the study. All subjects were on admission in the neurology wards of the University College Hospital, Ibadan at the time of the study. All ulcers were of grade IV according to Delisa and Mikulic [6] and located in the pelvic region. None of the patients were smokers since smoking has been shown to influence both the aetiology [14] and healing rate [15] of pressure ulcers in SCI patients.

Procedure

The rationale for the study was explained to the patients and their consent to participate was sought and obtained. The approval of the UI/UCH medical ethical committee was also sought and obtained. Subjects were then randomly assigned to either group A (IDC plus nursing care) or group B (placebo IDC plus nursing care). The assignment to groups was done by an individual with no knowledge of the treatment modality as a way of reducing investigator bias. Group A had 4 subjects and B had 3 subjects.

After cleaning, group A ulcers were covered with sterilized gauze soaked in 0.9% saline. Two pieces of aluminium plate electrodes cut to sizes slightly larger than the ulcers' perimeters were then attached to the leads of the IDC machine. (Duffield Mk7 by Duffield Medical Equipment Ltd; Goods Wharf, Goods Road, Beliper, Derbys). The electrodes were wrapped in 6 layers of lint soaked in 0.9% saline; the active electrode being placed directly over the ulcer and the inactive electrode on any suitable part of the body [16]. The IDC unit was then turned on and the intensity

Correspondence: Mr. B.O.A. Adegoke, Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan, Nigeria.

gradually increased until a 'minimal perceptible contraction' was produced. The intensity was then turned down to a level just below that capable of producing muscle contraction. The rest to surge ratio was 2:1 at a frequency of 30Hz and the wave form was rectangular. Each treatment session lasted 45 minutes as suggested by Kloth and Feedar [12]. This procedure was repeated for subjects of group B except that the intensity of the IDC unit remained on zero throughout the 45 minutes duration of the treatment. They hence received placebo IDC plus nursing care.

Measurements

Surface areas of the ulcers were measured pre-treatment and at the end of the second and fourth weeks of treatment. All measurements were taken by the same therapist (BKA) to ensure reliability. The surface area was measured using the procedure described by Balogun *et al.* [17]. The surface of a double sheet of tracing paper that will be in contact with the ulcer was first cleaned with methylated spirit. The ulcer's perimeter was then traced with a fine-tipped marker, the surface of the tracing paper in contact with ulcer cut off and the ulcer's impression transferred onto a metric graph paper from where the surface area of the ulcer was measured. The number of square millimeter on the metric graph paper which fell within the ulcer tracing were counted to determine the ulcer area to the nearest tenth of a square centimeter [12]. This method has been reported to have an intratester and intertester reliability of 0.99 and has hence been advocated for use in clinical practice as it is easy to use and inexpensive [18].

Data analysis

The initial surface area of ulcer was used to divide the change in surface area at the end of the second or fourth week and then multiplied by a factor of 100 to obtain the percentage decrease or increase in ulcer size thus:

$$\% \text{Change in surface area} = \frac{\text{Final surface area} - \text{Initial surface area}}{\text{Initial surface area}} \times 100 \quad (17)$$

Descriptive statistics of median, mean and standard deviation were also used to present the physical characteristics of the patients and ulcers.

Results

One of the patients requested to be discharged from the hospital before the end of the study hence was not regarded as being part of the study leaving three subjects each in both groups. The median age of subjects of group A was 54.0 years (mean = 52.7) while it was 36.9 years (mean = 35.0) for group B subjects. There were no statistically significant differences in the age of the subjects as well as physical characteristics of the ulcers of both groups (Table I). Thus, both groups were comparable at the beginning of the study.

The surface area of the pressure ulcers of group A decreased by 22.2% whereas it decreased by 2.6% in subjects of group B. Most of the decrease in surface area occurred during the first two weeks of the study (Table 2).

Table 1: Physical characteristics of subjects and pressure ulcers.

Variable	IDC+Nursing (group A) Mean±SD	Placebo-IDC+Nursing group B Mean±SD	t-value remark
Age (years)	52.7 ± 8.1	35.0 ± 13.5	*1.94
Ulcer duration (Wk)	12.0 ± 2.0	8.0 ± 2.0	*2.44
Ulcer surface area- Day 0 (mm ²)	15.8 ± 14.3	15.4 ± 3.2	*0.05
Ulcer location			
greater throcanter	2	1	
sacrum	1	2	
Diagnosis			
Quadriplegia	3	2	
paraplegia	0	1	

Table 2: Changes in surface area of pressure ulcers

Group	Week 0 Mean±SD	End of week 2 mean SD	% change	End of week 4 mean±SD	% change	Total change (%)
Group A	15.8±14.3	13.3±14.1	15.8	12.3±14.1	7.5	22.2
Group B	15.4±3.6	15.1±3.6	1.9	15.0±3.6	0.7	2.6

Discussion

Interrupted direct current (IDC) employed in this study appreciably augmented the healing rate of pressure ulcers in SCI patients. This is in agreement with the findings of Ogunjimi [10], Kloth and Feedar [12], Griffin *et al.* [13] and Umunnah [19]. The magnitude of the surface area reduction was similar to that reported by Ogunjimi [10] but considerably less than the 100% reported by Kloth and Feedar [13], the 67% reduction by Griffin *et al.* [13] and the 61% reduction of Umunnah [19]. The relatively lower percentage reduction in surface area could have been due to any of the following factors – the efficiency of the old IDC unit used in this study, the involvement of bedridden neurological patients as opposed to ambulant patients in some of the studies [10], [12], [19] with the attendant psychological effects of being bedridden, the frequency and total duration of treatment and perhaps the quality of nursing care received by the patients. In the work of Griffin *et al.* [13] which involved SCI patients like in this study, patients were treated with high voltage pulsed current (200 V) for twenty consecutive days whereas patients in this study received only twelve treatments over a period of 4 weeks.

Clinical implication

Pressure ulcers pose a serious problem in the rehabilitation of SCI patients and often result in huge expense of human and financial resources. This study has indicated that IDC stimulation, which is a relatively cheaper non-invasive treatment modality when used in conjunction with routine nursing care can accelerate the healing rate of pressure ulcers in SCI patients. While it is better and cheaper to prevent pressure ulcers, IDC treatment can reduce treatment time and cost as well as period of hospitalization of SCI patients who develop pressure ulcers. Unlike the high voltage pulsed current, which is equally effective but requires special units, the IDC is a common component of an electrical stimulating system.

Limitation/recommendation

The present study is limited by its small sample size, thus curtailing the generalization of its findings. Future studies should therefore involve a larger sample and control for such variables as nutritional and emotional status of the patients in the aetiology and prognosis of pressure ulcers. Future studies should also focus on the effect of IDC alone on pressure ulcers.

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