Evaluation effect of different concentration of povidone Iodine on skin wound healing in rabbits

Falah Mahmood Hameed1*, Hayder Mohammed Mohsen Al-Tomah1, Ali J. AL-Nuaimi1 and Ail Wasfi Sadeq1

1Veterinary Medicine College, University of Kerbala, Iraq.

*E-mail: falahsurgeon1976@gmail.com

Abstract. The goal of the current study was to assess the effects of povidone iodine 10% in comparison with 5% of povidone iodine on full-thickness cutaneous wounds healing in rabbits. This was on twenty-four healthy male rabbits, weighing from (1.5–1.8 kg). Under the effect of intramuscular administration of a mixture of xylazine hydrochloride 5mg / kg, ketamine hydrochloride 35mg / kg, and diazepam 1 mg / kg. On each animal, in the dorsal back area, one square (2 x 2) cm full-thickness skin wounds were made. The animals were divided into two groups, group (A) as the treatment group was treated with 10% povidone iodine daily for 1 time for day 7 post operation. While, at the same time in group (B), the rabbits were treated with 5% povidone iodine. For clinical evaluation, each group was divided into four subgroups (two wounds/subgroup) on 3rd, 5th, 7th, 14th and 21st days post-wound induction and treatment. Clinically, the result showed that 10 % of iodine was more effective than 5 % of iodine, and the wound healing rate in group (A) was faster than group (B). This was followed by statistical analysis results showing the wound healing process ((20%, 40%), (70%, 85%) contraction) and ((10%, 20%), (50%, 70%) re-epithelization). Respectively, there were significantly more (P≤0.05) than the iodine 5% during the study period. Conclusion; Povidone-iodine solution 10% is more efficient than iodine 5% so that lead to acceleration and enhancement of full-thickness cutaneous wounds healing.

Keywords. Iodine, Wounds healing, Rabbits.

1. Introduction

The wound healing in skin is an all-around coordinated endurance instrument that can be impacted by different conditions prompting a superior or worse course of healing [1]. As of late, there is an equally mounting proof that mental impacts (for example stress, social help, positive effect, and environmental enhancement) may also connect with wound healing [2]. In any case, infection and sepsis can be caused by spoiling with a pathogenic microbial agent, which disturbs the repair continuum [3, 4]. Infection evolution is driven by a dynamic relationship between the host and microorganisms, and further affected naturally and medicinal interventions [5]. There are a few germ-free skin-purging specialists accessible to the specialist to use for patients experiencing perfect, clean, clean-contaminated, contaminated, and dirty surgery. The conventional sterile purifying operator of decision is povidone iodine (PI). It is modest, viable, and the most regularly utilized operator of decision.
around the world [6]. Disinfectants are valuable choices for managing the bioburden in wounds with a wider range of antimicrobial adequacy, lower risk of anti-microbial obstruction progression, and minimal blowback to tissues. For that reason, the purpose of this study include assess and compare the effects of iodine in both concentrations, on full-thickness cutaneous wounds healing.

2. Materials and Methods

2.1. Experimental animals

Twenty four adult male rabbits (1.5 - 1.8 kg) divided into 2 groups (12 rabbits each) were used in this study. The rabbits were kept in the animal house of the College of Veterinary Medicine, University of Karbala, maintained in individual cages along the period of the experiment under normal environment including climate, management and feeding.

2.2. Surgical operation

In the dorsal back area of each animal, a square (2 × 2) cm full-thickness skin wound was induced. The animals were divided into two groups, group (A) as the treatment group was treated with 10% povidone iodine daily for once a day for day 7 post induction. While, in group (B), the rabbits were treated with 5% povidone iodine at the same style and for the same period.

2.3. Clinical evaluations

A total clinical assessment was performed on all animals at regular intervals along the time of the examination. Advanced photos were taken for all injuries after the zone had been shaved to envision the injury edge. The scab of each wound was deliberately evacuated for better imagination of the epithelization and granulation tissue zone by utilizing saline.

2.4. Statistical Analysis

The Statistical Analysis System [7] was used. Least Significant Difference –LSD test was used to determine the significance between groups.

3. Results and Discussion

3.1. Clinical Evaluation

In fact, the clinical statement of wounds seemed to indicate that through the current analysis, both treated wounds were rapidly reduced in size. The change began on day 3 in both treatment groups, which became evident on day 9, especially in wounds treated with 10% povidone iodine. This variation continued to occur until this research was completed. Clear differences emerged between the two treatment groups in total wound healing, mostly at the end of the study (Figure 1). During the 21 days of the study, the following-up of wound healing process appeared that the percentages of effect of concentration and day in length and width of wound contraction at 3rd, 5th and 7th without significant difference. While in the day of 9th, 14th and 21th of this study, the significant difference was clear with progress for 10% povidone iodine more than 5% povidone iodine(Table 1). At the same time, in the (Table 2) appeared the effect of concentration and day in the length and width of re-epithelization, which gave the same results that observed in the (Table 1).
Table 1. Effect of concentration and day in Length and Width of Wound contraction.

| Days | Length (Cm) | LSD value | Width (Cm) | LSD value |
|------|-------------|-----------|-------------|-----------|
|      | Conc. 10%   | Conc. 5% | Conc. 10%   | Conc. 5% |
| Day 3 | 1.50 ± 0.00 | 1.50 ± 0.00 | 0.00 NS | 2.00 ± 0.03 | 2.00 ± 0.00 | 0.00 NS |
| Day 5 | 1.40 ± 0.00 | 1.50 ± 0.00 | 0.113 NS | 1.90 ± 0.00 | 2.00 ± 0.00 | 0.113 NS |
| Day 7 | 1.30 ± 0.00 | 1.50 ± 0.00 | 0.175 * | 1.80 ± 0.02 | 1.90 ± 0.00 | 0.113 NS |
| Day 9 | 0.90 ± 0.00 | 1.40 ± 0.10 | 0.430 * | 1.30 ± 0.00 | 1.80 ± 0.00 | 0.337 * |
| Day 14 | 0.50 ± 0.10 | 1.00 ± 0.00 | 0.430 * | 0.60 ± 0.00 | 1.40 ± 0.10 | 0.430 * |
| Day 21 | 0.20 ± 0.00 | 0.70 ± 0.00 | 0.255 * | 0.40 ± 0.00 | 0.85 ± 0.05 | 0.215 * |
| LSD value | 0.141 * | 0.207 * | --- | 0.252 * | 0.217 * | --- |

* (P≤0.05).

Table 2. Effect of concentration and day in Length and Width of Epithelization.

| Days | Length (Cm) | LSD value | Width (Cm) | LSD value |
|------|-------------|-----------|-------------|-----------|
|      | Conc. 10%   | Conc. 5% | Conc. 10%   | Conc. 5% |
| Day 3 | 1.50 ± 0.00 | 1.50 ± 0.00 | 0.00 NS | 1.80 ± 0.02 | 1.90 ± 0.00 | 0.113 NS |
| Day 5 | 1.30 ± 0.00 | 1.40 ± 0.00 | 0.113 NS | 1.80 ± 0.00 | 1.90 ± 0.00 | 0.113 NS |
| Day 7 | 1.20 ± 0.00 | 1.40 ± 0.00 | 0.164 * | 1.70 ± 0.00 | 1.80 ± 0.00 | 0.113 NS |
| Day 9 | 0.80 ± 0.00 | 1.30 ± 0.00 | 0.175 * | 1.20 ± 0.00 | 1.70 ± 0.00 | 0.307 * |
| Day 14 | 0.50 ± 0.00 | 0.90 ± 0.00 | 0.268 * | 0.40 ± 0.01 | 1.30 ± 0.10 | 0.430 * |
| Day 21 | 0.10 ± 0.00 | 0.50 ± 0.00 | 0.252 * | 0.20 ± 0.00 | 0.70 ± 0.10 | 0.430 * |
| LSD value | 0.141 * | 0.157 * | --- | 0.271 * | 0.199 * | --- |

* (P≤0.05).

Figure 1. The study showed the difference in the wound contraction and re-epithelization between wounds treated with 5% and 10% iodine, at 3rd, 9th, 14th and 21st days post-treatment.
4. Discussion

4.1. Clinical evaluation

In povidone iodine, the iodine factor is carried by aggregation (or micelles) and is gradually released into the solution to verify its antiseptic effect [9, 10]. Exposure to povidone iodine leads to cell death by destroying the cell wall, cell membrane, and cytoplasm [11]. The solution of 10% povidone iodine is widely used and does not induce resistance to microorganisms [11, 12]. The effect of PVP-1 on microbial cells was also studied by [8] and found that it affects the structure and function of enzymes and cell proteins. It damages the function of bacterial cells by preventing hydrogen bonding and altering membrane structure. The rapid death of microbes is ensured by these numerous modes of action and helps prevent the production of bacterial resistance. Since the microbicidal activity of iodine is associated with many directly toxic effects on the cell wall rather than complex molecular pathways (as used by antibiotics), tolerance is highly unlikely and there are unusually rare reports of iodine-resistant strains [8]. In the current study, the assess and compare the effects of povidone iodine solution on the healing of full-thickness skin wounds in rabbits provided by several mechanisms, including bacterial growth prevention, acceleration of the formation of granulation tissue [3–7, on all post-treated groups. The clinical observations of wounds in the present study appeared that the level of development of healing process was started rapidly in both treatment wounds. But the progression was high in the 10% povidone iodine treated groups & than those in 5% povidone iodine treated groups significantly were continued to be present until the end of the study. These results are in agreement with other animal studies in which the effect of povidone iodine on wound microcirculation has also been studied. In rabbit ear chamber wounds, the use of a 5% povidone iodine solution was associated with an early but increasingly transient reduction in blood flow [13,14]. However, wounds showed faster neovascularization with povidone iodine treatment compared to silver nitrate, sodium hypochlorite, and untreated controls in the 10 %povidone iodine study mentioned earlier[15]. Another rat model showed no adverse effects on capillary blood flow after up to 60 minutes of exposure to 1% povidone iodine solution [13]. Interestingly, povidone iodine has been shown in a recent study to enhance wound healing through TGF b, not only by increasing granulation but also by enhancing neovascularization [16]. These results are very similar to the results obtained by Cooper, 2007, with increased bacterial activity in the diluted solution due to increased free iodine level (up to 26 ppm in 1% to 0.1% povidone iodine solution). On the other hand, some in vitro studies have shown that povidone iodine may have a measure of cytotoxic effect [18] and no consistent deleterious effects have been shown in in vivo studies on various wound healing measures, especially at lower
concentrations of povidone iodine[17,19]. Research has also shown that a number of animal studies on povidone iodine in wound healing, were published more than thirty years ago [17, 20]. Most have shown that concentrations of up to 10% do not necessarily inhibit granulation and epithelialization processes [17].

5. References

[1] Sorg H, Tilkorn DJ, Hager S, Hauser JR and Mirastschijski U 2017 Skin wound healing: an update on the current knowledge and concepts Eur. Surg. Res. 58 81.
[2] Broadbent E and Koschwanez HE 2012 The psychology of wound healing Curr. Opin. Psychiatry 25 135.
[3] Edwards R and Harding KG 2004 Bacteria and wound healing, Curr. Op. Infect. Dis. 17 91e96.
[4] Leaper DJ, Schultz G, Carville K, Fletcher J, Swanson T and Drake R 2012.Extending the TIME concept: what have we learned in the past 10 years Int. Wound J. 9 1e19.
[5] Konig B, Reimer K, Fleischer W and Konig W 1997 Effects of Betaisodona on parameters of host defense Dermatology 195 42e48.
[6] Hemani ML and Lepor H 2009 Skin preparation for the prevention of surgical site infection which agent is best? Rev. Urol. 11 190.
[7] SAS 2012 Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA
[8] Schreier H, Erdos G and Reimer, K 1997 Molecular effects of povidone-iodine on relevant micro-organisms: an electron-microscopic and biochemical study Dermatology 195 111.
[9] Chang FY, Chang MC, Wang ST, Yu WK, Liu CL and Chen TH 2006 Can povidone-iodine solution be used safely in spinal surgery Eur. Spine J. 15 1005.
[10] Cooper RA 2007 Iodine revisited Int. Wound J 4 124.
[11] Schreier H, Erdos G, Reimer K, Konig B, Konig W and Fleicher W 1997 Molecular effects of povidone-iodine on relevant microorganisms: an electron-microscopic and biochemical study Dermatology 195 111.
[12] Kunisada T, Yamada K, Oda S and Hara O 1997 Investigation into the efficacy of povidone-iodine against antiseptic-resistant species Dermatology 195 14.
[13] Burks RI 1998 Povidone-iodine solution in wound treatment Phys. Ther. 78 212e218.
[14] Brennan SS and Leaper DJ 1985 The effect of antiseptics on the healing wound: a study using the rabbit ear chamber Br. J. Surg. 72 780e782.
[15] Kjolseth D, Frank JM, Barker JH, Anderson GL, Rosenthal AI, Acland RD, Schuschke D, Campbell FR, Tobin GR and Weiner LJ 1994 Comparison of the effect of commonly used wound agents on epithelialization and neovascularization J. Am. Coll. Surg. 179 305e312.
[16] Wang L, Qin W, Zhou Y, Chen B, Zhao X, Zhao H, Mi E, Wang Q and Ning J 2017 Transforming growth factor b plays an important role in enhancing woundhealing by topical application of Povidone-iodine Sci. Rep. 9 991.
[17] van Meurs SJ, Gawlitta D, Heemstra KA, Poolman RW, Vogely HC and Kruyt MC 2014 Selection of an optimal antiseptic solution for intraoperativeirrigation: an in vitro study J. Bone Jt. Surg. Am. 96 285e291.
[18] Balin AK and Pratt L 2002 Dilute povidone-iodine solutions inhibit human skinfibroblast growth Dermatol Surg. 28 210e214.
[19] Burks RI 1998 Povidone-iodine solution in wound treatment Phys. Ther. 78 212e218.
[20] Vermeulen H, Westerbos SJ and Ubbink DT 2010 Benefit and harm of iodine in wound care: a systematic review J. Hosp. Infect. 76 191e199.