Comparison of Wound-bed Preparation Time in Chronic Traumatic Wound Using Topical Honey Application and Conventional Dressing

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Background: Prior to the definitive closure of wound by skin graft, it is essential for the recipient wound to be prepared adequately. Honey has been shown to exert a valuable effect in wound healing, atributale to its six favorable characteristics. This clinical study is proposed to determine the effectiveness of a specific sample honey (Madu Nusantara®) in accelarating the time of wound bed preparation in chronic traumatic wound.
Methods: A randomized non-blinded clinical trial was done on patients with chronic traumatic wound who required wound bed preparation before definitive closure, during a one-year period. A total of 18 patients were included in the study, divided into two interventions. One has wound treated by topical application of honey (HDR), and controls were treated by conventional dressing (CDR). Daily wound treatment and evaluation was done using The Bates-Jensen Wound Assesment Tool until wound-bed was ready to be skin-grafted. The time required until wounds were ready to be grafted was also measured in both groups.
Results: The mean time of wound bed preparation in HDR gorup was 12 days (n=11), and 26 days in CDR group (n=7, p 0.0055). The mean Bates-Jensen score of HDR improved from 45.45 before treatment to 23.36, versus 44.00 to 29.00 in CDR subjects.
Conclusion: A favorable wound bed is essential prior to skin grafting. Our data shows that topical application of honey is more effective in accelerating the time of wound bed preparation than conventional dressing in patients with chronic traumatic wound.
Keywords: *Wound bed preparation, chronic traumatic wound, honey, conventional dressing*

Latar belakang : Sebelum terjadi penyembuhan luka secara definitif melalui *skin graft*, persiapan secara adekuat untuk luka merupakan hal yang penting. Madu telah terbukti memberikan efek yang bermakna dalam penyembuhan luka, melalui enam karakteristik yang bermanfaat. Penelitian klinis ini bertujuan untuk membedakan efektifitas dari madu sederhana (Madu Nusantara®) dalam mempersingkat waktu persiapan dasar luka pada luka traumatis kronis.
Metodologi: *A randomized non-blinded clinical trial* dilakukan pada pasien dengan luka traumatik kronis yang memerlukan persiapan dasar luka sebelum penutupan luka secara definitif, dalam waktu 1 tahun. Penelitian melibatkan 18 pasien, dibagi menjadi dua kelompok perlakuan. Kelompok pertama diberikan madu topikal (HDR), dan kelompok kontrol dilakukan *dressing* konvensional. Perawatan dan evaluasi luka sehari-hari menggunakan *The Bates-Jensen Wound Assessment Tool* hingga dasar luka siap untuk dilakukan *skin graft.* Waktu yang dibutuhkan hingga luka siap untuk dilakukan *skin graft* jika diukur pada kedua kelompok.
Hasil : Waktu rata-rata persiapan dasar luka pada kelompok HDR adalah 12 hari (n=11), dan 26 hari pada kelompok CDR (n=7, p 0.0055). Rata-rata nilai Bates-Jensen pada HDR meningkat dari sebelum perawatan sebesar 45.45 menjadi 23.36, vsedangkan pada kelompok CDR dari 44.00 menjadi 29.00.
Kesimpulan: Dasar luka yang baik merupakan hal yang penting sebelum melakukan *skin graft.* Data kami menunjukkan pemberian madu topikal lebih efektif dalam mempersingkat waktu persipan dasar luka dibanding *dressing* konvensional pada pasien luka traumatis kronis.
Kata kunci: *Wound bed preparation, chronic traumatic wound, honey, conventional dressing*

In general, wound management includes the assessment of wound, wound bed preparation, dressing and closure of the wounded skin.[1] Wound bed preparation is a process which aims to eliminate barriers on the wound surface which will allow healing to take place in an optimal time. Wound bed

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preparation is achieved by bacterial control, removal of necrotic tissues and maintaining wound moisture.[2,3,4] Prior to the definitive closure of wound, for instance by skin grafting, wound bed has to be well prepared to facilitate the success of graft-take.[5,6,7]

Wounds are classified into acute and chronic wound based on the time they require to heal. The definition of chronic wound used in this study is those which take longer than one week to heal. This type of wound has a delayed healing process in one of its phase, usually during the inflammatory phase, and has difficulties to progress into complete healing.[1,8-11] Chronic wounds may contain eschar, frequently has granulating tissues and a consequently higher bacterial colonisation and rate of infection.[7] Chronic wounds pose surgeons a greater challenge to close definitively, this is where wound bed preparation plays an important role. Four aspects should be monitored in preparing a wound bed: 1) Tissue management, 2) Infection and inflammation control, 3) moisture balance, and 4) epithelial advancement.

One of the most crucial aspect in wound bed preparation is to remove barriers of necrotic or unhealthy tissues which inhibits healing, by doing debridement. Chronic wound may require repeated debridements to achieve favourable wound bed compared to acute wounds. There are 5 options to wound debridement including surgical, autolytic, enzymatic, mechanical, and biosurgery.[1,3,12] The selected method will depend on wound size, location, aetiology, the risk and presence of infection, overall patient status, and cost. In most cases, combined methods can be incorporated such as in this study.[1] As surgeons, we are most familiar to surgical debridement, and it is the quickest method to remove dead tissues. However, surgical debridement clease not only unwanted tissues but healthy ones as well, risks for bleeding exists and patients must first be declared fit for such procedure. In between surgical debridements, combined method by less invasive debridement procedure may be opted. In this study topical agent (honey) is applied on the wounds to initiate an enzymatic debridement process.

Honey as Debridement Agent

From the ancient times since the days of Hippocrates, and also written in Qoran and Bible, honey has been documented to exert a valuable effect in wound management. Honey contains 35% glucose, 40% fructose, 5% sucrose, 20% water, amino acis, vitamins, minerals, and enzymes.[13] Its favorable actions on the wound are owed to its six characteristics: anti-inflammatoric and antibacterial activity, promotes autolytic debdridement, reduces malodour, maintains a moist wound environment, and stimulates healing.[14,15] The high sugar concentration absorbs water from the surrounding environment, yet maintains moist on the wound surface. The pH level of honey is between 3.4-6.1 is shown to inhibit bacterial growth, and its high osmolarity produces hydrogen peroxide when diluted as it comes in contact with body heat.[16,17] In a previous study (unpublished) it was demonstrated that honey is effective in hindering growth of pseudomonas on wound surface.[16-18]

Two hypothesis describes the action of honey in debriding wound: 1) it activates plasminogen into palsmin, an enzyme which has the ability to release the adherent fibrin of slough and eschar on wound bed, and 2) tis high osmolarity draws fluid from lymph circulation, which provides a constant protease supply to the wound bed and release necrotic tissues.[15] Rapid elimination of slough can stimulate healthy granulating tissue; initiate angiogeneis; accelerate epithelialization; exert anti-inflammartoric activity which reduces pain, edema, and exudate; and minimize the formation of hypertrophic scarring.[18,19] In addition, the high viscosity of honey is a barrier to bacterial colonization and creates a moist environment, favorable to healing. The proliferation of phagocytes, B and T lymphocytes cell in a cultured media is enhanced by honey application at a 0.1% low concentration. At 1% concentration honey was

shown to stimulate monocytes and release cytokines, tumor necrosis factor alpha, interleukin-1 and -6; which in combination activates the immune responce of patients when infection is present.[8,14,15] A systematic review in 2001 of several randomized clinical trials which used honey as topical agent on wounds showed that in six out of seven studies, honey was superior than conventional dressing in promoting wound healing, maintaining wound sterility, and eliminating infection.[8]

The application of topical agent should be combined with the appropriate dressings to cover the wound. To date, there is no single dressing which suits all kinds of wounds, nor mostly recommended. Whichever dressing opted, it should ideally: protect the wound from mechanical trauma and bacterial invasion, accelerate reephitelialization, stimulates the exchange of gas, maintains moisture, non-adhesive, non-toxic, not allergenic, absorb odors and exudates, sterile, clinically applicable, comfortable for the patient, and cost-effective.[1,20,21] The selection of dressing is based on individual assessment and treatment purposes. We select the use of conventional dressing by gauze with normal saline for

METHODS

controls. The intervention group with honey application are applied using gauzes as well.

The present study is an non-blinded clinical trial designed to evaluate the effectiveness of a local honey (Madu Nusantara®) compared to that of conventional dressing in accelerating wound bed preparation in chronic traumatic wound. Subjects are patients treated in the ward of our hospital between July 2010 and July 2011, with chronic wounds which require wound bed preparation before definitive closure. Samples are acquired consecutively, with the exclusion of patients whose age were younger than 5-year-old, older than 60-year-old, suffered chronic trauma due to other aetiology than trauma, patients with uncontrolled diabetes melitus, or unfavorable nutritional state (serum albumin <3 gr/dL).

Eighteen patients with chronic wounds due to trauma were treated in our ward during the period of study. They were divided into two groups: 11 in the HDR (honey dressing) group, and 7 in the CDR (conventional dressing) control group. Patients who fulfilled study criteria first underwent general wound evaluation using the Bates-Jensen (BJ) wound assessment tool. Bates-Jensen score incorporates wound size, depth, edges, cavity or dead space, type and ammount of necrotic tissue, type and amount of exudate, local changes of skin color around wound, peripheral tissue edema and induration, quality of granulating tissue, and the presence of epithelialization.[22]

Patients were then randomised into either intervention (HDR) or control group (CDR). Wounds of the HDR group were treated by local application of honey soaked in dry gauze then covered by layers of clean gauze. Wounds of patients in the CDR group were treated using moist NaCl 0.9% gauze covered by layers of dry gauze. In all patients, wound dressings were changed two times per day. Bates-Jensen scoring was evaluated once a day. Serial surgical debridement and swab examinations for microorganism culture were performed when necessary. Data is then presented as overall demographic of subjects and its distribution. The Mann-Whitney nonparametric test was used to analyse the mean difference within the two groups using SPSS 16.0 for Windows.

The specific parameters used in BJ assessment tool defines the following. Size is presented as wound surface area measured by multiplying the length and width of wound. Depth is either with no break on the skin surface, presence superficial abrasion or blisters, deep crater, unable to be visualised due to necrotic tissue, or an exposed deeper supporting structures such as tendon or joint capsule. Edges are either indistinct, attached, unattached, rolled under, callous-like (hyperkeratotic), or fibrotic (hard and rigid). Cavity is asses by inserting cotton tipped applicator under the wound edge, and distance of undermined tissue is measured from the wound edge to the cotton tip. Amount of

necrotic tissue is measured in ratio to the percent of wound involved. Types of necrotic tissue is either white/grey, non-adherent or loosely adherent, yellow slough, or soft and hard black eschar. Types of exudate depends on the predominant exudate found on the dressings in contact with the wound: bloody, serous, serosanguineous, purulent, or foul purulent. Amount of exudate found on the dressing determines whether there is no exudate, scant (moist wound, not measurable exudate), small (<25% dressing), moderate (25 to <75% of dressing), or large (≥75% of dressing). The colour of skin around the wound include those within 4 cm of the wound edge, and is either bright red, dark red, or pink. Peripheral tissue oedema and induration is also assessed within a 4 cm radius from the wound. Granulating tissue is evaluated as bright red or pale pink, reflecting its state of vascularity. Epithelialization is measured using a transparent metric device with concentric circles divided into 4 pie-shape quadrants to assess the pink or red skin epithelium which has covered the wound

RESULT

A total of 18 patients with chronic traumatic wound who required wound bed preparation were included in the study during the one-year period. Wounds were prepared using honey dressing (HDR) in eleven patients, and saline dressing (CDR) were used in the remaining seven. Age of patients varied from 13 to 60 years of age, most of them males (77.8%). Almost all subjects suffred from crhonic traumatic wound on the extremities (27.8% upper, 66.7% lower), with only one subject had wound on the posterior trunk. Summary of the study subjects are listed in Table 1. The progress of wound healing in both treatment groups were analyzed using the Bates-Jensen (BJ) wound assessment tool prior to intervention, once daily after wound care, and at the end of treatments when wound beds were deemed favorable for skin-grafting. The

Table 1. Summary of subjects

Characteristics	HDR (n=11)	CDR (n=7)
Age (year)		
Mean	34	44
Median (min, max)	36 (13,55)	50 (25,60)
Gender		
Male	8	6
Female	3	1
Wound Location		
Upper extremity	2	3
Lower extremity	8	4
Posterior trunk	1	nil
Initial BJ Score		
Mean	45.45	44.00
Median (min, max)	44 (35,61)	45 (36,52)
Finale Score BJ		
Mean	23.36	29
Median (min, max)	24 (20,27)	29 (25,35)
Preparation time (days)		
Mean	11	26
Median (min max)	10 (6; 30)	21 (15,60)

HDR: Honey dressing, CDR: Conventional dressing

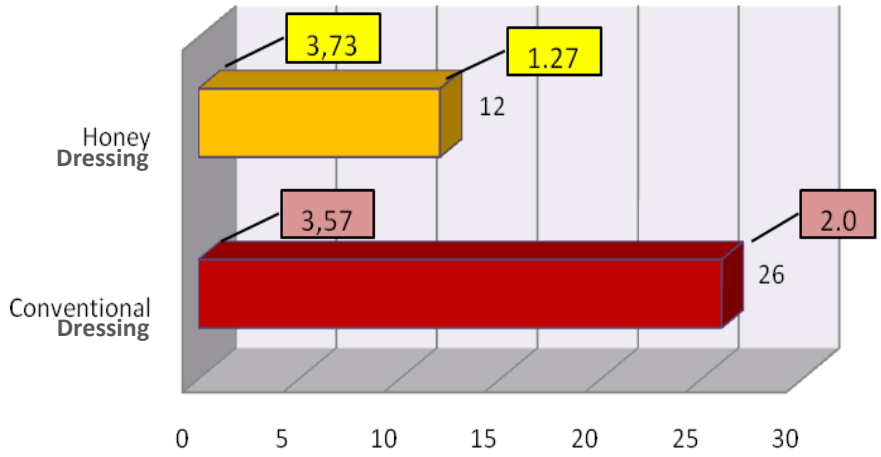

Figure 1. Bates-Jensen score of the exudate amount between wounds in the honey dressing compared to conventional dressing group, before treatment initiation and at the end.

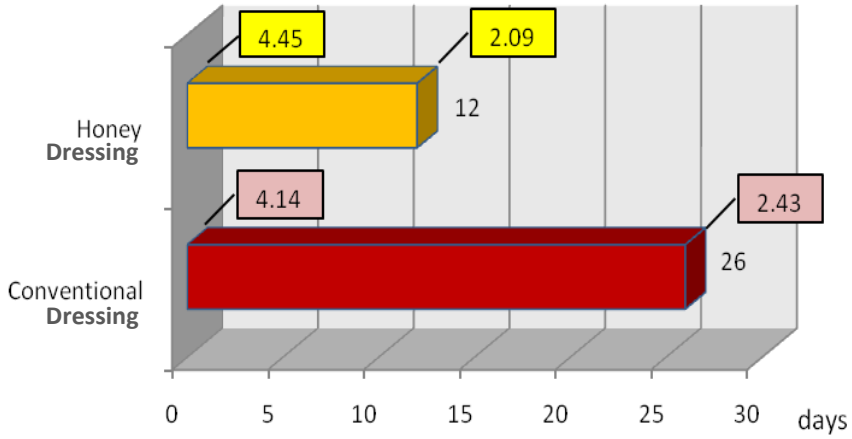

Figure 2. Comparison of amount exudates score between honey dressing and conventional dressing

time required for wound beds to attain the state of preparedness were measured in both groups. In HDR group, the average time required to prepare wounds adequately was 11.9 (rounded up to 12 days), while in CDR group it took 26 days (p=0.0055).

The BJ wound assessment tool evaluated 13 independent variables from wounds to quantify the healing process. These variables and their scoring are listed in Table 2. Other than the overall score improvement (the lower the more favorable), we selected two criterias to deterimine that wounds were adequately prepared to then be grafted: the amount of exudates and granulating tissues. In HDR patients, amount of exudates before treatment was 3.73 and improved to 1.27 at the end of wound bed preparation. The initial exudate score among CDR patients was 3.57, which went down to 2.0 at the end of treatment (Figure 1). Granulating tissue score in the HDR group prior to honey dressing applications was 4.45 and progressed to 2.09 after treatment, while granulating tissues in the CDR group was at initial BJ socre 4.14 and improved to 2.43 at the end of wound preparation (Figure 2). The time required to attain this state of preparedness were faster in the HDR group compared to CDR, as stated above and also displayed in Figure 1 and 2.

Prior to wound bed preparation, patients underwent surgical debridement to

Figure 4. Wound bed showed granulation tissue in 6 days

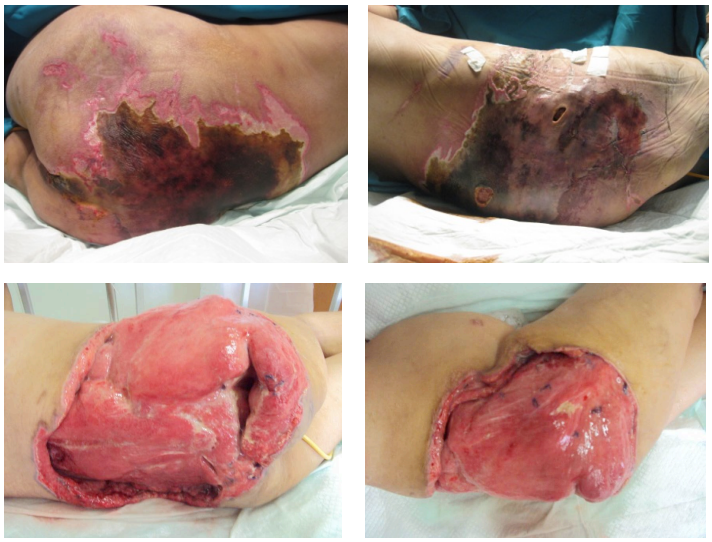

Figure 5. Granulation tissue although above bone expose without periosteum at sacral region

remove necrotic tissue. The fastest wound to attain preparedness for skin grafting within the HDR group, its BJ score improved from 44 to 25, was within six days. Initially, eschar and unhealthy granulating tissue was present on the dorsum of hand, and on the forehand circumferentially (Figure 3, upper row). Some slough on the surface of granulating tissue was present. After one surgical debridement and 6 days of wound care by honey dressing application, healthy granulating tissue covers the whole wound area (Figure 3, bottom row). The quickest wound bed preparation in the HDR group took 15 days, a postamputation wound below the knee, whose BJ score went down from 36 to 25.

The slowest time to attain an ideal wound bed within the HDR group was 30 days, where BJ socre improved from 61 to 27. Patient had a history of closed degloving injury on the lumbosacrogluteal region, with exposed sacral bone and preperitoneal fat after surgical debridement (Figure 4). Regular honey

DISCUSSION

dressing for wound preparation was combined with serial surgical debridement. On day 30, healthy granulating tissue covered all wound area including over the exposed sacral bone, and the whole defect was resurfaced using skin graft. In the HDR group, subject with a defect on the volar arm through to the digit webs and exposed ulnar bone had the slowest wound bed preparation time. After 60 days of wound care using normal saline dressing BJ score progressed from 52 to 30, and wound was finally suitable for grafting.

Patients with extensive injury and large wound surface, complicated by unfavorable systemic condition are not suited to defect resurfacing by using flap. Skin grafting is a practical alternative. Prior to a definitive

Table 2. Wound characteristics and Bates-Jensen score in honey dressing and conventional dressing group

	Initial BJ score		Final BJ score	
	Control (n=7)	Honey (n=11)	Control (n=7)	Honey (n=11)
Size	3.71	3.36	3.71	3.36
Depth	4.14	4.27	2.71	2.55
Edges	3.14	3.00	2.71	2.18
Undermining	2.57	2.82	1.29	1.09
Necrotic Tissue Type	3.71	4.00	1.86	1.86
Necrotic Tissue Amount	4.29	4.09	1.43	1.43
Exudate Type	3.57	4.18	2.43	2.43
Exudate Amount	3.57	3.73	2.00	1.27
Skin Colour Surrounding Wound	2.14	2.55	1.14	1.09
Peripheral Tissue Oedema	2.86	2.55	1.29	1.29
Peripheral Tissue Induration	1.14	1.73	1.36	1.93
Granulation Tissue	4.14	4.45	2.43	2.09
Epithelialization	4.82	4.82	4.64	4.64
TOTAL SCORE	**44.00**	**45.45**	**29**	**23.36**

BJ: Bates-Jensen, HDR: Honey dressing, CDR: Conventional dressing

closure of wound by skin grafting, optimalization and preparation of wound bed plays a vital role in minimizing the risk of graft failure. Vascularized healthy tissue provides a favorable bed for graft to survive on. In adjunct to surgical debridements when indicated, two methods of wound bed preparation are used in this study: the application of topical honey dressing (HDR), and saline dressing as controls (CDR). All wounds were due to trauma and located mostly on the upper and lower extremities. Subjects in HDR group attained wound bed preparedness faster, and had a greater overall BJ score improvement, compared to subjects in the CDR group. The result which favors honey over saline are attributed to the six characteristics of honey as stated in the study background, which promotes healing in general.

Among the 11 subjects in the HDR group, 4 patients had wounds with exposed bony structure. Three of them had wounds on the lower extremities, and one in the sacral region. Healthy granulating tissue grew over the bone in all cases, within 11 to 30 days, and then successfully covered by split-thickness skin graft. The rate of growth of granulating tissue was influenced by the depth of wound bend. Honey stimulated the generation of granulating tissue over bony surfaces even when periosteum was absent. The chemical properties of honey cleanse wound surface quickly by removing slough, which then initiates the growth of healthy granulating tissue, angiogenesis, epithelialization: which together accelerates the wound healing process. The anti-inflammatory activity of honey also reduces pain, edema, and exudates.[18,19]

Two subjects in the HDR group were complicated by sepsis by Pseudomonas and Methycillin resistant Staphylococcus aureus (MRSA). Culture examination revealed resistance of both bacterias to all antibiotics except Meropenem. Honey has been demonstrated to exert a broad-spectrum antibacterial activity locally, and the application of honey dressing on chronic traumatic wound on these two cases has shown to reduce the duration of systemic antibiotic use. Previous unpublished study by Diah and Sudjatmiko showed the effectiveness of honey against P. aeruginosa and MRSA.[23]

Conventional dressing by using normal saline and gauze acts as a mechanical

debridement with the working principle of wet-to-dry dressing. Wounds were covered by gauze moistened with normal saline, in the process of gauze turning dry, dead tissues will attach to the gauze. When the dressing is removed, debris and necrotic tissues which were trapped in the gauze pads were mechanically separated from the wound bed. This step however, destroys the newly formed granulating tissue and fragile epithelial cells along with it. This is the potential cause of maceration around the wound bed, and exerts

CONCLUSION

pain on the patients during change of dressings. Wet-to-dry dressing is the simplest method of mechanical debridement, but it requires a frequent dressing change, between 2 to 6 times per day depending on the level of saline and moist saturation in the pads. The progress of granulating tissue growth on wounds dressed by the conventional dressing required longer time, because the process of wet-to-dry dressing change injure some of the newly formed tissues. It possess no anti-inflammatory and antimicrobial activity. This ensued in a slower wound bed preparedness, and prolonged hospital stay.

Patients with extensive traumatic injuries complicated by systemic conditions who are not fit for wound defect coverage using flaps, may alternatively be skin-grafted. Prior to skin grafting, wound bed must be favorably prepared to facilitate the success of grafts. Application of topical honey dressing is shown to be more effective in accelerating the time of wound bed preparation than conventional saline dressing in chronic traumatic wound. This method may reduce the patients length of hospital stay.

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