Dressing for Partial Thickness Burn Using Microbial Cellulose and Transparent Film Dressing : A Comparative Study

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Background: Wound dressing aims are to create moist and warm condition to accelerate wound healing, decrease level of pain, collects of exudate, decrease the need of dressing changes, cost effectiveness and protection from bacterial contamination. Microbial cellulose creates a moist environment and strong adhesion to the wound to prevent bacterial contamination and protects from temperature changes. Meanwhile transparent film dressing has advantages such as easy to evaluate, rapid rate of epithelialization and provides high comfort for patients. This study aims to evaluate the efficacy of microbial cellulose dressing compare to transparent film dressing as control, in the treatment of partial thickness burn.
Method: We perform a single blind randomized clinical trial study. All patients with partial thickness burn with total body surface less than 20% area burns at any age presenting to our burn unit will be included in the study. They were dressed using microbial cellulose and transparent film as control.
Result: The epithelialization rate of patients treated by microbial cellulose was significantly faster and less pain, especially in day 3 and 10 (p=0,000) than those treated with transparent dressing. This study showed patient using microbial cellulose no need to change dressing, meanwhile in transparent dressing it need 2 to 3 times dressing changes and costs more money.
Conclusion: The use of microbial cellulose dressing is a versatile and effective dressing for partial thickness burns. This innovative material will be an alternative dressing in partial-thickness burn wounds.
Keywords: *Microbial cellulose, transparent film dressing, partial thickness burn*

Latar Belakang: Pembalutan luka bertujuan untuk membuat kondisi yang lembab dan hangat guna mempercepat penyembuhan luka, mengurangi nyeri, mengumpulkan eksudat, menurunkan kebutuhan pergantian balutan, meningkatkan efektifitas biaya, dan juga melindungi dari kontaminasi bakteri. *Microbial cellulose* menciptakan lingkungan yang lembab dan perlekatan yang kuat ke luka untuk mencegah kontaminasi bakteri dan melindungi dari perubahan temperatur. Sementara itu, penggunaan *transparent film dressing* memiliki kelebihan yaitu mudah untuk evaluasi luka, laju epitelisasi yang cepat dan menyediakan kenyamanan yang tinggi pada pasien. Penelitian ini bertujuan untuk mengevaluasi efikasi dari *mircobial cellulose dressing* dibandingkan dengan *transparent film dressing* sebagai kontrol, pada penanganan *partial thickness burn*.
Metode: Kami melakukan *single blind randomized clinical trial study*. Seluruh pasien dengan *partial thickness burn* dengan *total body surface area* (TBSA) kurang dari 20% yang datang ke unit luka bakar disertakan dalam penelitian ini. Pasien kemudian diberikan *dressing* menggunakan *microbial cellulose* dan *transparent film* sebagai kontrol.
Hasil: Laju epitelisasi dari pasien yang diberikan *microbial cellulose dressing* lebih cepat dan tingkat nyeri yg lebih ringan, khususnya pada hari ke 3 dan 10 (p=0,000) daripada pasien yang diberikan *transparent dressing*. Penelitian ini menunjukkan pasien yang menggunakan *microbial cellulose* tidak perlu pergantian dressing, sementara pasien dengan *transparent dressing* membutuhkan 2-3 kali penggantian *dressing* sehingga membutuhkan lebih banyak biaya.
Kesimpulan: *Microbial cellulose dressing* adalah *dressing* yang serbaguna dan efektif untuk *partial thickness burns.* Material inovatif ini akan menjadi *dressing* alternatif untuk *partial thickess burn wounds.*
Kata Kunci: *Microbial cellulose, transparent film dressing, partial thickness burn*

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Decision-making in the treatment of burns remains a challenge despite improved assessment techniques and treatment

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procedures. Approximately 500,000 persons seek medical treatment for burns every year in the United States. Of these, approximately 40,000 are hospitalized for burn injuries, including 25,000 admissions to the approximately 125 medical centers that specialize in burn care. Typically, 4,000 people die from fire and burns every year. Of these, approximately 3,500 deaths are due to residential fires, and 500 are due to motor vehicle and aircraft accidents, electrical injuries, chemical exposures, or hot-liquid and substance spills. Among fatalities, nearly 75% die at the scene of the incident or during initial transport. Of those who reach medical care, infection is a major cause of morbidity and mortality in Indonesia. Latest data issued by RSCM burns unit showed that 60% were caused by household accidents, 20% due to workplace accidents and 20% were due to other causes. Mortality from burns in Indonesia was still high, around 30%, mainly due to severe burns. The initial response to thermal injury involves direct heat-induced protein denaturation and cell death. This is followed by inflammation and ischemia-induced injury, which cause burns of varying skin depth.

Partial thickness burns are exceedingly common in children and present a challenge in treatment. Partial thickness burns are characterized as superficial or deep and typically present with pain, fluid-filled blisters, and redness. Unlike full thickness burns, effective wound care in the treatment of partial-thickness burns is crucial to good wound healing outcome. The management of these burns relies on preserving the unburned dermal and epidermal appendages in the wound bed, promoting re-epithelialization. The optimal partial thickness burn wound dressing provides protection from bacterial contamination, decreased heat and water loss from the wound, decreased pain as sensory nerve terminals are covered, elimination of daily dressings changes, and ease of instructing patient / family on home.[1]

One of the common dressing materials used for partial thickness burn is transparent polyurethane film. However single disadvantage of polyurethane films is uncontrolled leakage leads to discomfort patient and ward staff.[2]

Microbial cellulose is a natural polymer synthesized by Acetobacter xylinum. In 1886, A.J. Brown published an article on the cellulose-producing activity of these bacteria. The cellulose has a leathery, thick membrane that can hold a quantity of water without any discomfort. As a result, it is considered to be a biomedical material suitable as a wound dressing. Nowadays, intensive research efforts have revealed the effectiveness of this type of dressing when used on ulcers, including burn wounds. Hemicellulose dressings can induce adhesion and sustain the proliferation of fibroblasts in the human skin. The dressing may have highly desirable characteristics as an ideal skin substitute. Moreover, it has remarkable moistening and cooling properties. It may be used on superficial burn wounds in order to balance wound moisture and protect wounds from bacterial invasion. The aim of this study is to document our experience of using microbial cellulose compared to transparent film dressing and to asses the efficiency of this material.[3]

METHOD

This research was a preliminary study single blind randomized controlled clinical trial to compare the rate of epithelialization in partial thickness burn between the transparent film dressing and microbial cellulose dressing. The study conducted in burn unit of Cipto Mangunkusumo General Hospital, Plastic Surgery Division. Timing of study was from June 2012 - January 2013. Patients with partial thickness burn which meet the inclusion and exclusion criteria would undergo treatment of the wound. Inclusion criteria were patients with partial thickness burn, patients with total body surface area of burns less than 20%, and willing to follow the research, while exclusion criteria were patients with full thickness burn and patients with burn caused by electrical, flame, chemical, and inhalation trauma. Samples were randomized into a treatment group that received dressing using microbial cellulose compared with the control group who received dressing with transparent film

The identity of each patient will be recorded, caused of burn determined, the burn surface area would be counted and degree would be estimated. Operator was one resident

of plastic surgeon (as researcher). Wound would be evaluated on day 1, 3, 7, and 10. The wound dressing was changed on day 3, 7 and 10, if there were exudations in transparent dressing or there was a detachment of microbial cellulose dressing. Parameters to be recorded were rate of wound healing, level of pain, necessity of dressing change and cost effectiveness.

RESULT

A total of 16 patients entered the trial and divided into two groups, each 8 patients. The age ranged from 3 to 24 years. Gender male to female comparison was 11 to 5 patients. Total body surface area for transparent dressing was 10 to 18 percent, and in microbial cellulose dressing was 10 to 19 percent (Table 1).

Mean age of patient using transparent dressing was 13, 13 years old, the youngest was 3 year old and the eldest was 21 years old. The 95% Confidence interval using transparent dressing was between 6,48 to 19,77 years old. Mean age for patients using microbial cellulose is 14,88 years old, the youngest is 4 years old and the eldest is 24 years, The 95% Confidence interval using microbial cellulose is between 7,47 years old and 22,28 years old.

Mean TBSA using transparent dressing was 15,63%, with the lowest TBSA was 10% and the highest was 18%. The 95% Confidence interval using transparent dressing was between 13,21% to 17,94%. Mean TBSA using microbial cellulose was 15,75, with the lowest TBSA was 10% and the highest was 19%. The 95% Confidence interval using microbial cellulose was between 7,47% to 22,2% (Table 2).

The epithelialization rate of patients treated with microbial cellulose were significantly faster than those treated with transparent dressing (microbial cellulose vs transparent dressing: 8,13 days vs 12,63 days with p value 0,000). In three patients using microbial cellulose, the epithelialization happened in day 7, while in one patient using transparent dressing the epithelialization happened in day 11.

The level of pain in patient using microbial cellulose was less than patient using transparent dressing, especially in day 3 and 10 (p=0,000). In day 3, the pain score in patient with microbial cellulose ranged from 3 to 4 while the pain score in patient with transparent dressing ranged from 5 to 6. In day 10, the pain score in patient with microbial cellulose was none to 1 while the pain score in patient with transparent dressing ranged from 2 to 3.

This study showed patient using microbial cellulose no need to change dressing, meanwhile in transparent dressing it need 2 to 3 times dressing changes, because of exudation. Patients using

Table 1. Age Distribution

Dressing	n	Mean	Min	Max	95% Cl
Transparent Dressing	8	13,13	3	21	6,48-19,77
Epigraft	8	14,88	4	24	7,47-22,28

Table 2. Total Body Surface Area Distribution

Dressing	n	Mean	Min	Max	95% Cl
Transparent Dressing	8	15,63	10	18	13,31-17,94
Epigraft	8	15,75	10	19	12,86-18,64

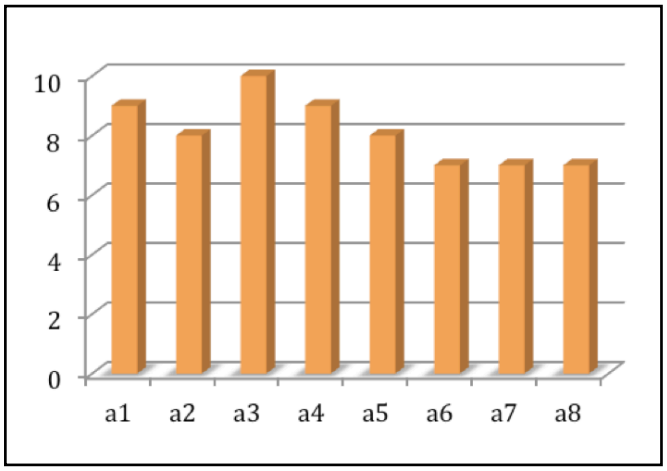

Figure 1. Epithelialization rate of microbial cellulose dressing

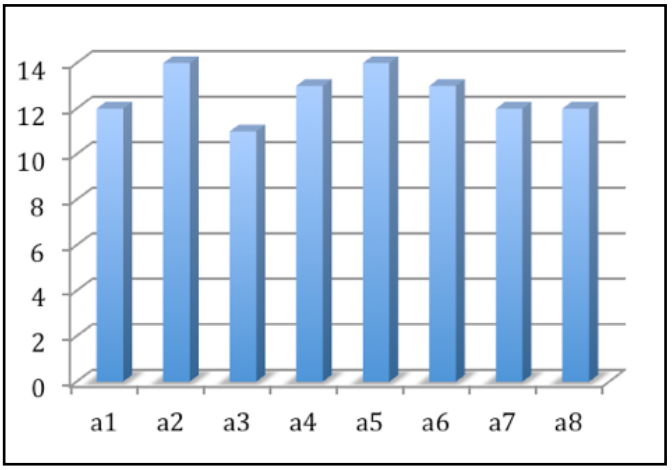

Figure 2. Epithelization rate of transparent film dressing

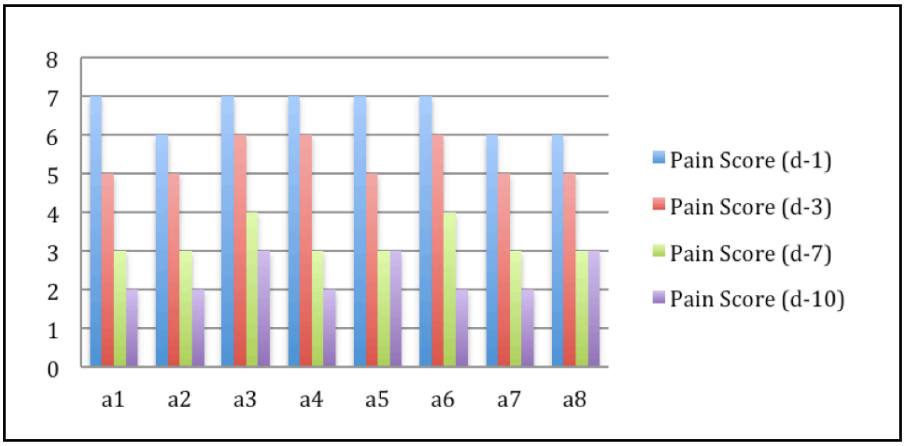

Figure 3. Pain score in patient treated with microbial cellulose dressing

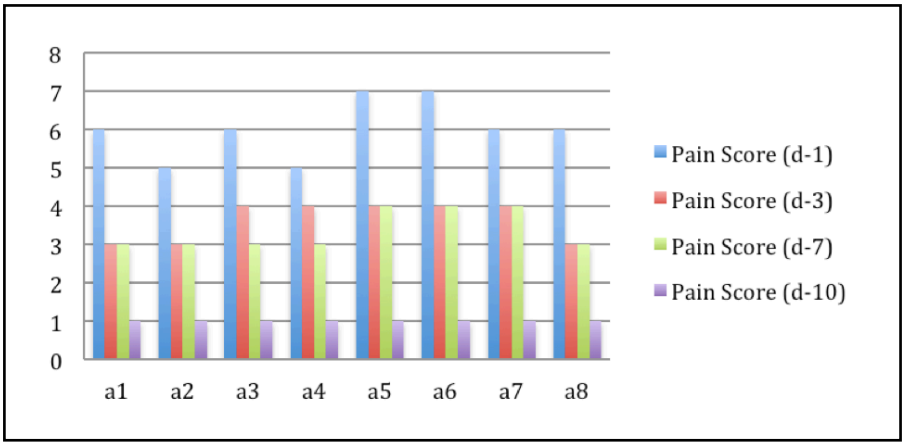

Figure 4. Pain score in patient treated with transparent film dressing

Figure 5. Treatment day 1 of a 29-year-old male with 18% partial thickness burns on the posterior trunk and bilateral upper extremities. **Left and upper right :** Treatment using microbial cellulose on the posterior trunk and upper right extremity. **Lower right :** Treatment using transparent dressing on the left upper extremity.

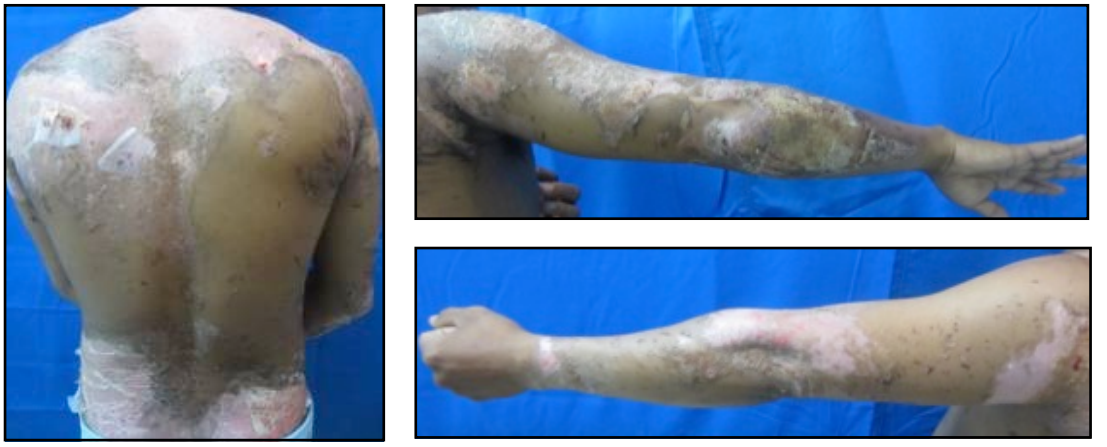

Figure 6. Result of treatment of day 5 of the same patient.

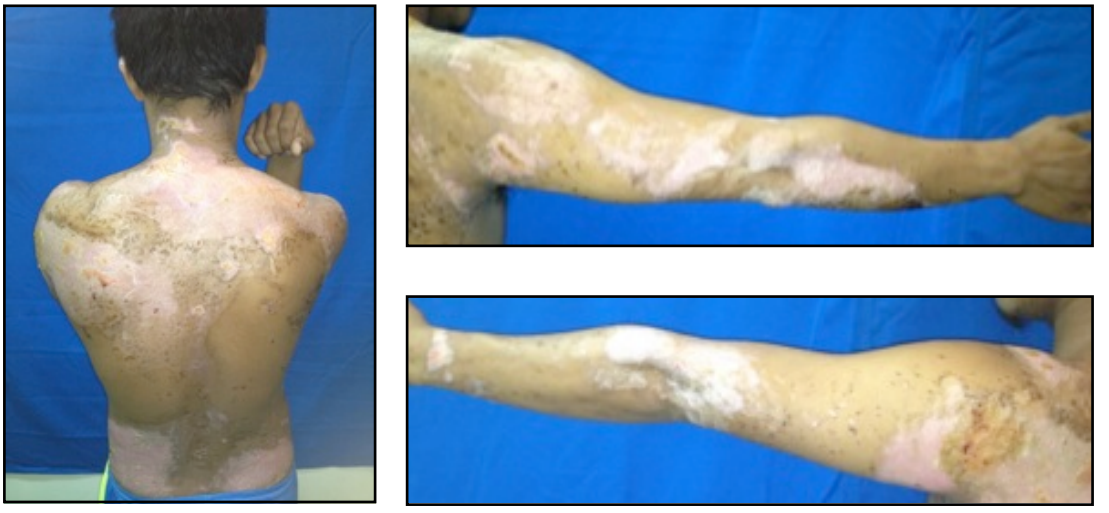

Figure 7. Treatment day 7 and patient then discharge home.

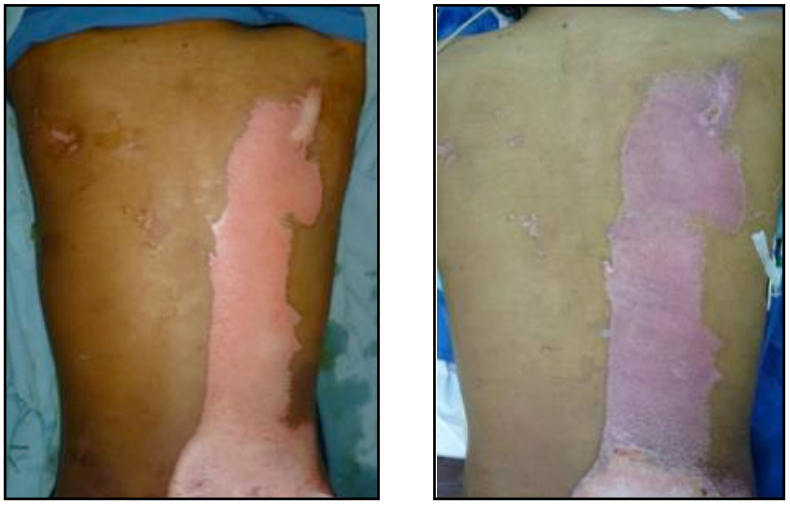

Figure 8. A 23-year-old male suffered 3% second degree burn on the posterior trunk due to fire. **Left :** Treatment day 1. **Right :** Treatment day 7.

Figure 9. Left : A man with second-degree burn on right lower extremity. At first we used transparent dressing but the patient complained of having severe itch. **Right :** After we changed the dressing we found several blisters and decided to change the dressing with microbial cellulose.

transparent dressing need 2 to 3 times changing dressing which means it needed IDR 296000 to 444000. Meanwhile patients using microbial cellulose did not need to change the dressing and only cost IDR 256000.

DISCUSSION

One of the major aims of burn treatments is to quickly accomplish wound closure in order to increase the rate of healing and to provide immediate pain relief. In addition, proper wound management must avoid any infection or dehydration

Second-degree burns are defined as those burns in which the entire epidermis and variable portions of the dermis layer are destroyed. A superficial second-degree (partial thickness) burn is characterized by heat injury to the upper one-third of the dermis, leaving a good blood supply. This type of burn usually heals within 10 to 14 days. Because the follicular region is not injured, cell growth is possible and sebaceous glands and hair follicles are developed in the new epidermis. However, the patient will experience severe pain because the sensory nerves in the dermal layer are not injured. Winter reported in 1962 that the wound-healing process, especially re-epithelization, is accelerated in moist wounds. It is now commonly accepted that a moist wound environment hastens the healing of both acute and chronic wounds and promotes the growth of new tissues. A balanced

moist surface in acute wounds facilitates the action of growth factors, cytokines, and chemokines, thus promoting cellular growth and the construction of a wound matrix. A treatment that has moisturizing and cooling effects on the burn wound may be beneficial to the patient.[3]

Several treatment options exist for the treatment of partial thickness wounds. Thorough cleansing, wound debridement, and application of antimicrobial agents such as mafenide acetate (Sulfamylon; UDL Laboratories), 1% silver sulfadiazine (Silvadene; Monarch Pharmaceuticals, Bristol, TN), or bacitracin were the standard of care until synthetic skin substitutes and modern topical agents were developed.[1]

Microbial cellulose may be a novel dressing for partial thickness burn wounds. Its accelerated wound-healing properties have been investigated in only a few clinical studies but have shown effective results. The dressing is derived from a bacterium named A.xylinum and cultured in liquid medium. The structure of its cellulose from complex processes differs from other plant cellulose. An ultrafine network of cellulose nanofibers can hold a large amount of water while displaying great elasticity, a high degree of wet strength, and conformity. This network may be suitable for providing a moist environment in burn wounds in order to promote wound healing.

Fontana et al and Mayall et al studied this cellulose dressing in burns and chronic ulcers. This wound dressing material is more effective than others. It provides pain relief, protects the wound against infections, and accelerates wound healing. Another study revealed that microbial cellulose dressings proved to be more effective than conventional wound dressing materials in the treatment of chronic venous ulcers

In this experiment we report the use of microbial cellulose as a dressing to heal burn wounds. The application on our patient resulted in complete resolution of a moist environment for healing, protected from additional injury from scratching, and accelerated wound healing. The only side effect occured here was allergic reaction that we found in one patient.

CONCLUSION

The use of microbial cellulose dressing is a versatile, effective dressing for partial thickness burns from infancy to adulthood. It provides a moist environment, a cooling effect, and activation of wound healing, as well as improvement in pain reduction. Not forget to mention it's cheaper since it doesn't need a changing of dressing. This innovative material will be an alternative dressing in partial-thickness burn wounds.

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